THE

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CONTENTS:

	PAGE
Boiler Explosions	189
America and Germany as Competitors	190
Siphon Recorder Signals (*illustrated*) (*continued*)	191
On Oscillatory and Rotatory Magnetic Fields, and the Theory of the Single-phase Motor (*illustrated*)	194
Notes on Higher Voltage Trolley Wires	196
A Two-Speed Travelling Electrical Platform	197
The Latest Submarine Boats	197
The A B C Arc Lamp (*illustrated*)	198
Correspondence:—	
Cowper-Coles's Electrolytic Cyclic Process	201
A Last Word on Cyclic Electrolysis of Ores, &c.	202
Heating Lamps	202
Dublin Electrical Contractors	202
Rotating Cathodes	202
The Nernst Incandescent Lamp	202
Legal	203
Business Notices, &c.	203
Notes	211
City Notes	213
Traffic Receipts	216
Share List of Electrical Companies	217
Market Quotations	218
Acceleration	219
The Metrical System	219
An Experience of Motor Haulage	220
The Electro-metallurgical Laboratory at Aachen Polytechnic	220
Second-hand Boilers	221
Electric Lighting and Fuse Destruction in St. Pancras	221
Some General Observations on Electric Traction.—Discussion (*continued*)	222
Some Questions re Municipal Electrical Trading	224
Application of the Electric Motor to Warships (*concluded*)	224
Papers by M. A. Blondel	226
A True Story	227
New Patents	227
Abstracts of Published Specifications	228

THE

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BOILER EXPLOSIONS.

A WRITER in the *Mechanical World* advocates the interference of the Board of Trade with stationary boilers. We cannot assent to the wisdom of this. Undoubtedly the system of the Marine Department has worked well at sea, but when a ship is at sea it is not in port. This is an obvious truism, prompted by the fact that a factory is always in port, and the same port, and it is very unlikely that the interference of State officials could be tolerated. The boiler insurance companies have done a good work, and are to be credited with the great advance in boiler using which has come about during the past 40 years, and though it is sometimes urged that rates have been unduly cut down by competition, we see no trace of this in the share lists and dividends paid, though there may have been an unnecessary parsimony in the staff payments. There is something which deters a man buying up an old condemned boiler and using it until it "pops off," for already the Board of Trade are empowered to inquire into boiler explosions and to levy fines, while coroners also inquire and juries find verdicts of manslaughter. It is no joke to be responsible for the safe working of a boiler, and any engineer who is so responsible will usually endeavour to persuade his employers to have the services of the insurance companies to relieve him at so small an annual cost, of such a weight of responsibility. The onus of responsibility always attaches particularly to the more technical man in a joint responsibility, and if a coroner's inquest comes to be held, the non-technical man will usually clear himself by indicating his child-like trust in his colleague. While we would not countenance the rapid promotion from farm labourer to boiler tender, spoken of by the correspondent, we would also be averse from the certification of men by the Board of Trade. The inevitable result would be, we fear, that many fit men would be excluded from work, and many unfit men would be admitted. Probably, far more good would be done by a compulsory system of boiler registration, such as we have already advocated, wherein should appear the name of the person or association responsible for the boiler being allowed to work with its pressure and equipment. Such a safeguard we are sure would be created by this method as to very largely augment the number of boilers enrolled on the lists of the insurance companies. It is the small vertical boilers of little men which are the most dangerous, because they are so easily endangered by shortness of water, and this is so very probable a contingency. We know of a case where a small vertical is employed which cannot suffer from water shortness to the point of danger. Shortness of water is a danger to which internally fired boilers are always prone, and from which externally fired boilers do not so readily suffer. The multi-tubular or locomotive type boiler so much affected by the agricultural engineer is probably the best possible in skilful hands, but it never appears suitable for the attention of the yokel. There is an opening for a

really good agricultural boiler of a type which, if fitted with a couple of locked safety valves, could not be seriously endangered by low water to the risk of the public. Locomotive type boilers are very inaccessible to inspection, and are liable to faults of an insidious nature, and at best without tube removal their safety can only be inferred from the appearance of such parts as are visible, their age, or the known time which has elapsed since they were re-tubed.

AMERICA AND GERMANY AS COMPETITORS.

The practical abandonment of the Monroe doctrine by America in entering upon a course of policy which has brought her into contact with the other nations of the world, has probably done more to secure a true realisation of the doctrine than all the Chinese walls that have been previously attempted.

Mr. L. G. Magee writes suggestively in the *Engineering Magazine* respecting the feelings of Americans abroad, who are straining every nerve to secure and maintain a commercial foothold, and must wonder at the indifference of their people at home. This indifference has been explained by Richard Olney as due to a kind of theory of superiority and of risk of contamination from any outside nation. Just as the Chinese denoted Europeans as Western barbarians, so Americans called them Eastern paupers. The Old East and the New West met one another in ideas, as well as in geography, and both tried to hide the outside world behind a wall, the Chinese, towards the West, of bricks, the Americans, towards the East, of tariffs. Curiously enough, too, the same year which saw China receive the blow which denotes the end of her isolation, saw America, with as little self-intention, strike the blow which has done for her what other nations have done for China. America may now be said to be out in the hurly-burly, and will have to make the best of it, and a very good best seems likely to fall to her lot. The American who has travelled with intelligence is not behindhand in recognising that America has no claim to be considered first in everything. In electrical work America certainly takes the lead, but she fails in other matters, and our author thinks that America should improve her consular service in respect of the lack of commercial and scientific experts to study conditions abroad and report to enlightened officials at home.

Germany is strengthening her consular service, and keeps an especially keen eye upon German trade abroad, quietly, and at small cost, and Mr. Magee is responsible, also, for the statement that German exporters have been warned against using methods or publishing statements derogatory to articles of foreign make. This is described as high-minded. We fear certain Sheffield manufacturers have cause to know that this high-minded policy follows only on very low-minded practices. Germany also has a system of temporarily calling in experienced non-official outsiders for advice in both State and municipal affairs, and our author makes reference, also, to the large numbers of men who serve gratuitously on city committees and are above suspicion. Thus a medical man of European reputation considers it an honour to serve on a public baths committee.

This seems strange to Americans, whose municipal government is not usually good, but altogether the sport of political bosses. In England this kind of unpaid service is still more common than in Germany, at least, outside London, and more especially in the smaller towns below 100,000 of population, where everyone is too well known, for abuses to creep in, and yet the numbers are too great for a monopoly of squire and parson. The class of men on a London vestry are, as a rule, inferior to the class which is found on the councils of country boroughs. A tribute is paid to the German trade schools, though it is claimed that in methods and equipment the American technical schools compare at least favourably with those of Germany. Germany, of course, profits by her organisation, and this is rendered possible by the predominating militarism of the country, and is a factor which must somehow be otherwise counterbalanced in Anglo-Saxon communities.

American Boilers.

It is a common belief that the water-tube boiler is peculiarly significant of American practice. This is by no means so. The American boiler is probably the externally fired cylindrical type with flat ends flanged to the shell and stayed with tubes, gussets, and tie rods. A paper by Mr. Le Van, a well-known boiler expert in America, describes an improved form of this boiler, which the author considers on the whole to be the best form of boiler. In the improved form there is a steam drum attached by one flanged neck piece only to the front end of the shell crown, thus avoiding strains of expansion. As illustrative of dimensions, the shell is 54 inches diameter and 17 feet long, the steam drum being 12 feet. There are 45 tubes of 4 inches external diameter. The grate measures 8 feet × 4 feet, but preferably it is divided longitudinally by a brick wall with two grates, an improvement of doubtful utility. Only 4·7 square inches of air opening is allowed in the fire-door for auxiliary air. The boiler is set 3 feet above the grate —a good practice, much to be preferred to shallow spacing. The flue gases pass all under the shell right up to water level and return by the tubes, whence they pass up to the top of the boiler and escape around the steam drum having probably a drying effect on the steam, though superheating is claimed. The water-heating surface is 934 feet, or nearly 30 times the grate; the steam-heating surface is 107 feet, the area through the tubes is 3·4 feet, or, say, one-ninth the grate area; and a series of evaporative tests are claimed to have given about 11¼ lbs. evaporation per pound of combustible from and at 212°. The combustion rate was low, only from 9 to 11½ lbs., so the maximum evaporation was only 3 lbs. per foot of water-heating surface. Features to be objected to are the punching of the rivet holes, though these are punched 3/32 small and rimered out and the damage done is not so serious after all; the supply of water through the blow out pipe, which ought not to be done, nor should this be unprotected, as it is shown. The shell and steam drum plating is parallel, but telescopic, the rear ends being the larger. There is much to be said for this class of boiler, especially for export to new countries, and when the steam drum can be sent separately, to facilitate carriage and rolling. Boiler insurance companies are averse to underfired boilers of shell type, especially where the feed water is bad, but this is a fault which seems to have been, perhaps, overstated, and it is certain that thousands of American boilers are thus made and worked at very high pressures. We think the type of boiler might be studied with advantage for export work, even without steam drum at all. Those who have had huge boilers to deal with in the absence of facilities for moving them, will appreciate our contention.

SIPHON RECORDER SIGNALS.

By J. RYMER-JONES.

(*Continued from page* 79.)

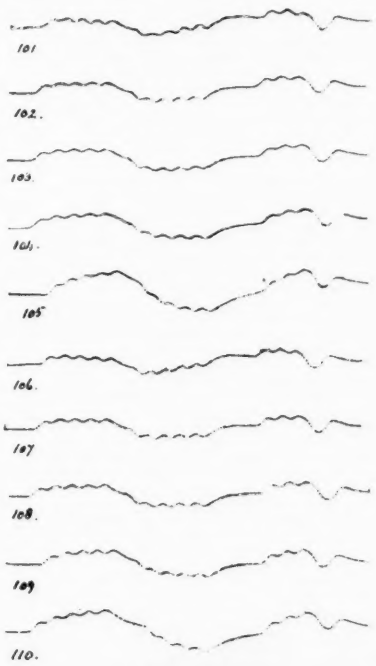
Effect of Shunting the Signalling Condensers.

Shorter cable c. 20 mfds. at one end only. 30 cells. 16 w.p.m.

Recorder s = 40^{ω}.

Slip 101 s on s c = ∞			Slip 106 s on r c = ∞		
102	= 40,000	No. r c used.	107	= 40,000	No. s c used.
103	= 30,000		108	= 30,000	
104	= 20,000		109	= 20,000	
105	= 10,000		110	= 10,000	

Slip 101 shows the normal signals without any shunt on s c. With $40,000^{\omega}$ or $30,000^{\omega}$ shunting s c signals are more parallel with the zero line (102 and 103). When further reduced to $20,000^{\omega}$ or $10,000^{\omega}$ a succession of similar signals have a decided *rise*, showing that the shunting has been overdone (104 and 105). A shunt of $5,000^{\omega}$ shows the movement towards the zero line decreasing and the



Slips 101 to 110.

movement from it, of the same element, increasing, thus tending to wipe out definition and produce a smoother and more wavy line, as would be expected, seeing that the curbing effect of the condenser is so much reduced by the low resistance shunt between its terminals.

When the condenser is transferred from the sending to the receiving end precisely the same and equal effects are produced as when s c is shunted (slips 106 to 110).

It will be noticed that even so low a resistance as $10,000^{\omega}$ between the condenser terminals does not greatly affect definition, but this resistance is too low if the cable be subject to earth currents.

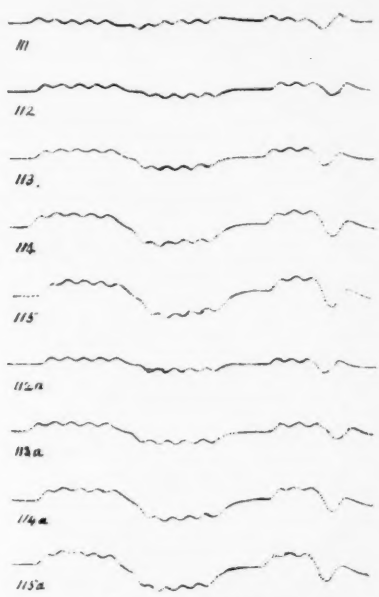
Condensers of 20 Mfds. at Both Ends.

30 cells. 16 w.p.m. Recorder s = 200^{ω}.

Slip 111 s on s c = ∞			Slip 111 s on r c = ∞		
112	= 10,000	Shunt on r c. ∞	112*a*	= 10,000	Shunt on s c. ∞
113	= 5,000		113*a*	= 5,000	
114	= 2,500		114*a*	= 2,500	
115	= 2,000		115*a*	= 2,000	

Slip 111 shows the normal signals without any shunt on s c and r c. The several elements are in a tolerably straight line *except the first*, which rises a little beyond the rest, and gives the appearance of a slight fall to succeeding elements. All signals cross the zero line. A shunt of 10,000 prevents this (112 and 112*a*), makes them more even and improves signals.

With $2,000^{\omega}$ shunting s c (115 and 115*a*) signals are bodily raised a good deal above the zero line, and the first element does not reach so far as the others, which show a



Slips 111 to 115a.

decided fall. This is noteworthy, as shunting either s c or r c, *when only one of them is used*, has the opposite effect and makes signals *rise*, as is also the case with the longer cable, c, when condensers of 50 mfds. are used at both ends.

The same slips represent equally well the effect of the same shunts on the receiving condensers, r c, instead of on s c. The definition of every element is as sharp and the amplitude practically the same, whether the shunt resistance between the terminals of s c (or r c) be ∞ or only $2,500^{\omega}$ and the effect of decreasing the condenser shunt is to raise all signals wholly above the zero line, and prevent them throwing across it. As far as the writer is aware, the effect of a shunt on the condenser to prevent signals *falling* was first pointed out by Mr. Nesworthy, electrician to the Western and Brazilian Telegraph Company, in a communication some 20 years ago to the Society of Telegraph Engineers.

Longer cable c. 50 mfds. at one end only. 30 cells. 16 w.p.m.

Recr. s = 60^{ω}

Slip 116 s on s c = ∞		
117	= 20,000	No r c used.
118	= 10,000	
119	= 5,000	

The same slips represent equally well the effect of the same shunts when the condenser is removed to the receiving end.

Slips 116, 117, 118 and 119, representing shunts on the condenser of respectively ∞, $20,000^{\omega}$, $10,000^{\omega}$ and $5,000^{\omega}$ show an increased *rise* for consecutive similar signals from the zero line as the shunt on s c is decreased.

Slips 120, 121, 122, and 123, show respectively the same with 100 mfds. at only one end of c, s on recorder = 50^{ω} —30 cells—16 w.p.m.

Until the condenser shunt is reduced to $20,000^{\omega}$ there is not a great difference in the size or shape of a succession of similar elements, but with $5,000^{\omega}$ signals become much larger and very wavy—in fact, more closely resembling signals without any condenser, as would be expected.

Condensers at both ends. s c and r c both 50 mfds. 30 cells.

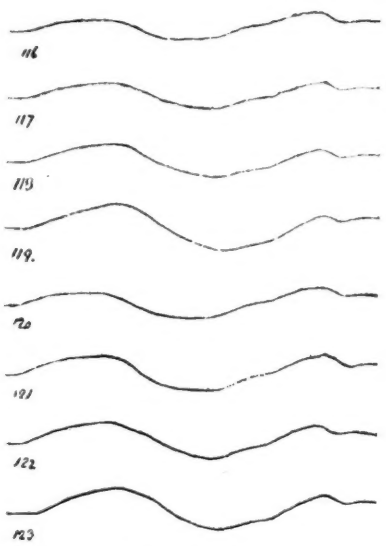
16 w.p.m. Recr. s = 800^{ω}.

Slip 124 s on s c = ∞		
125	= 20,000	s on r c ∞
126	= 10,000	
127	= 5,000	
128	= 3,000	

The same slips represent equally well the effect of the same shunt on r c instead of on s c.

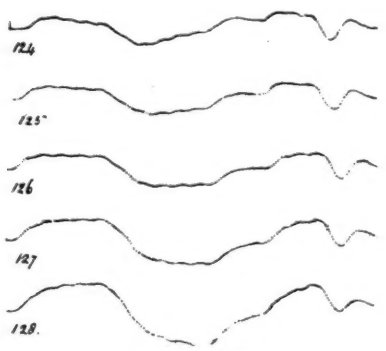
Slip 124 shows the natural *fall* in consecutive signals, and slip 126 shows this fall counteracted by a shunt of 10,000$^{\omega}$ on S C and made parallel with the zero line.

With 5,000$^{\omega}$ on S C (127) the shunting is excessive, and the signals consequently *rise*. Varying the shunt or S C (or R C)



Slips 116 to 123.

while the condenser at the other end remains unshunted does not make a great difference in the *definition* even when the shunt is reduced to 10,000$^{\omega}$. With 3,000$^{\omega}$, however, on S C



Slips 124 to 128.

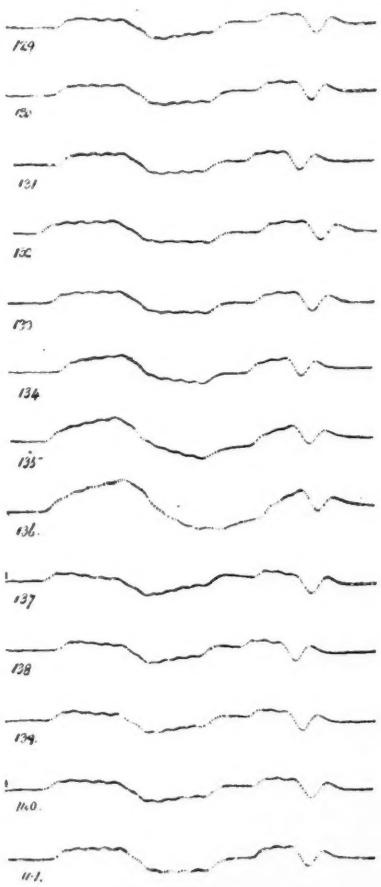
(or R C), signals through this long cable lose their definition and become wavy and considerably removed above the zero line (slip 128). With 100 mfds. at both ends, and S on the recorder = 150$^{\omega}$ the same remarks apply, but signals are not so well defined with these larger capacities.

shunted with 20,000 (slips 129 to 136) a shunt of 30,000$^{\omega}$ on S C brought the signals parallel with the zero line (slip 131), whereas *without* 20,000$^{\omega}$ on R C (slips 137 to 141) 10,000$^{\omega}$ was required on S C to produce parallelism (slip 141).

The same slips represent equally well the effect of shunting S C permanently with 20,000$^{\omega}$, and compensating it by shunting R C.

Slip 129, S on S C	= ∞,	normal signal, S on R C = 20,000$^{\omega}$.
130	= 40,000	"
131	= 30,000	"
132	= 20,000	"
134	= 10,000	"
135	= 5,000	"
136	= 3,000	"
137, S on S C	= ∞	S on R C = ∞,
138	= 40,000	"
138	= 30,000	"
140	= 20,000	"
141	= 10,000	"

Note.—Slip 133 shows S C and R C reversed.



Slips 129 to 141.

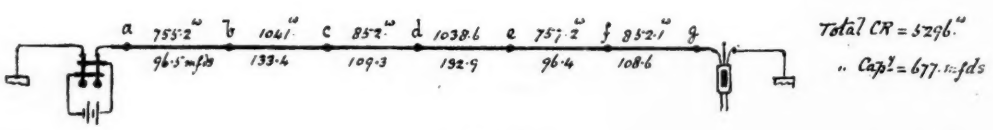


Fig. 1.

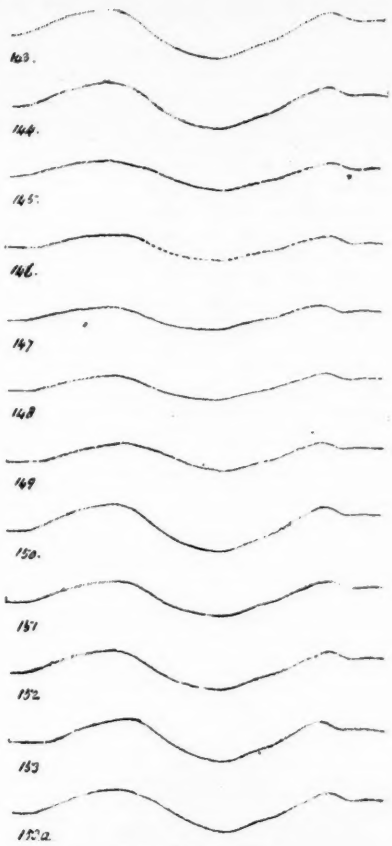
Effect of Signalling Condensers having Low Insulation Resistance.

Long cable C. Condensers, S C and R C, both 50 mfds. 30 cells. 16 w.p.m. Recr. S = 1,000$^{\omega}$.

A condenser with low insulation resistance is equivalent to a shunted condenser and has the effect of raising signals from the zero line. Consequently when R C was permanently

It will be apparent, therefore, that when the employment of both sending and receiving condensers shows a *fall*, or if the K R of the cable be sufficiently low to give very sharply defined signals with only a sending or receiving condenser, it is a positive advantage to use condensers of low insulation, because not only is the fall thereby reduced but the signals are farther removed from the zero line, and thus rendered less confused. When, however, the cable is subject to strong

and varying *earth currents*, condensers of low resistance are a source of trouble as they allow these currents to enter the cable and confuse signals.



Slips 143 to 153a.

The effect of weak insulation in the *cable* is to produce a *fall* towards the zero line which condensers, having a low insulation resistance, tend to compensate.

Effect of Leaks on Signals.

Long cable c.—No condensers at either end. 30 cells. 16 w.p.m.

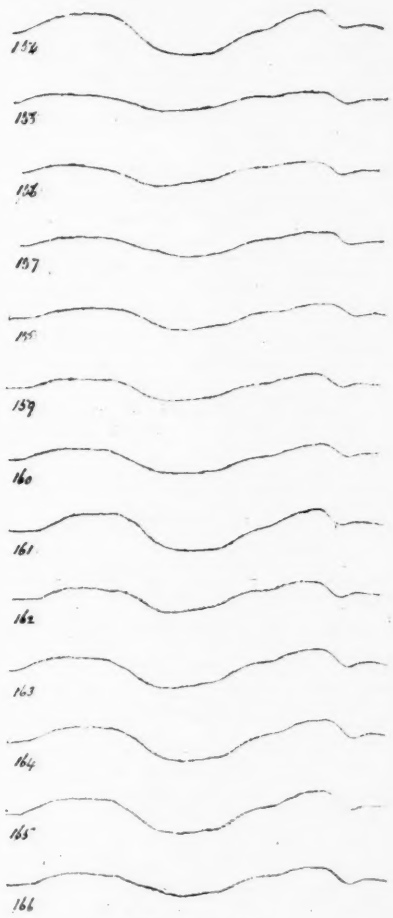
Recr. s = 20^{ω}.

(Fig. 1.)

Slip 143, no leak on cable.

144, leak of $1{,}000^{\omega}$ at point *a*.
145 " *b*.
146 " *c*.
147 " *d*.
148 " *e*.
149 " *f*.
150 " *g*.
151, with 5 leaks each $10{,}000^{\omega}$, at *b*, *c*, *d*, *e*, *f*.
152 " $20{,}000^{\omega}$ "
153 " $30{,}000^{\omega}$ "
153*a* " $40{,}000^{\omega}$ "

A leak of $1{,}000^{\omega}$, at *g* (150), makes no noticeable difference to the normal signals without any leak (slip 143). The maximum effect of this leak is obtained when placed at point, *d*, (147), waves are then much reduced and nearly parallel with the zero line, but there is no definition. The shunt may, however, be increased, and improve the speed slightly by making them larger. Leaks of $10{,}000^{\omega}$ at the five points indicated above make signals less wavy than without leaks (151) but not so parallel with the zero line as $1{,}000^{\omega}$ at *d* (147), and they are rather more wavy than slips 145 and 149.



Slips 154 to 166.

Long cable c.—Condenser of 50 mfds. at only one end. 30 cells. 16 w.p.m. Recr. s = 120^{ω}.

(Fig. 2.)

Slip 154, no leak on cable. s c = 50 mfds. No r c.

155, leak of $1{,}000^{\omega}$ at point, *a*.
156 " *b*.
157 " *c*.
158 " *d*.
159 " *e*.
160 " *f*.
161 " *g*.

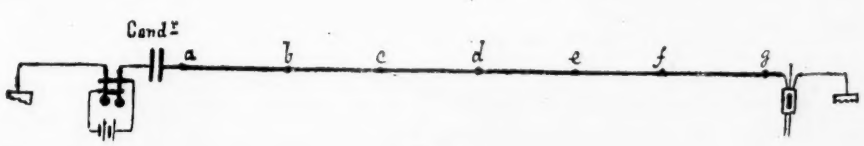


Fig. 2.

162, with 6 leaks each $10{,}000^{\omega}$, at *a*, *b*, *c*, *d*, *e*, *f*.
163 " $20{,}000^{\omega}$ "
164 " $30{,}000^{\omega}$ "
165 " $40{,}000^{\omega}$ "

r c = 50 mfds. No s c.

Slip 166, with 6 leaks each $10{,}000^{\omega}$ "

A leak of $1{,}000^{\omega}$ reduces signals most when at the sending end, *a* (155), and least at the distant end, *g* (161). In fact, it only reduces signals, in the latter position, in proportion as it acts as a shunt on the recorder coil. There is not much difference between 158 and 159 in which cases signals are most parallel with the zero line, and therefore best. If the recorder shunt be increased these signals would be larger and admit of a slightly increased speed of working. At the condenser end (155) the fall is greatest. Six leaks (162) give about the same signals as 158 or 159, or slightly larger, and 163 signals are larger still, tolerably parallel with zero and perhaps the best. These are all a decided improvement on the normal signals without a leak, and therefore are capable of a somewhat higher speed for signalling than when no leak is on the cable (154).

With the condenser at the *receiving end* a leak of $1{,}000^{\omega}$ at the *sending end* makes little difference in the amplitude of received signals, and no apparent difference in the definition from that which results when no leak is employed.

When the leak of $1{,}000^{\omega}$ is placed at the *receiving end*, signals are reduced in size and are represented by slip 155, where the leak was at point *a*, close to the *sending* condenser. That is to say, the effect of a leak on received waves depends on its position with regard to S C or R C. When at the condenser end, or at point *b c d* or *e*, signals are smaller, more parallel with the zero line and therefore rather better defined than when no leak is on the cable, so that the leak is beneficial.

(*To be continued.*)

ON OSCILLATORY AND ROTATORY MAGNETIC FIELDS, AND THE THEORY OF THE SINGLE-PHASE MOTOR*

By MICHAEL B. FIELD.

It is not infrequently the case that when the engineer comes to inquire into the precise conditions which govern the working of alternating current machinery, he is confronted with a problem of such complexity that he finds it well nigh impossible to represent by algebraic symbols the exact conditions which should determine the details of design of similar machines in the future. He is consequently obliged to make certain assumptions, which, although he knows them to be erroneous, sufficiently simplify matters as to render them amenable to simple methods of calculation.

The engineer will then often reason with himself in the following wise: "On account of certain erroneous assumptions I have made, it is only to be expected that my calculated result will be, say, *k* times the true result as determined by experiment. I will, therefore, calculate a number of machines on the same basis and compare the experimental with the calculated values, thus determining my 'coefficient' (*k*) for quite a number of different machines of various sizes, and will make use of the coefficients thus obtained to guide me in the future in obtaining results nearer to the actual truth."

A great deal of designing is carried out on this principle of employing all sorts of coefficients determined by experiment to atone for discrepancies which creep into the result, owing to false assumptions in the first place.

It is, however, often the case that by discarding the well-known rule-of-thumb methods and inquiring more deeply into the inner nature of the working of such machinery that facts are discovered which point out the road to improvements in the future.

The main object of this paper is to investigate the analysis and synthesis of various forms of magnetic fields with a view to arrive at a satisfactory standpoint from which to attack the theory of the single-phase motor and to develop an approximate method for calculating the same. To render the arguments used hereafter as concise as possible, we will begin by clearly defining the exact sense in which several expressions (in themselves more or less ambiguous) are used, and then treat briefly of the decomposition of more or less complicated magnetic fields into their simpler constituents, exemplifying our deductions with references to many of the well-known phenomena in connection with the working of alternate current motors.

The magnetic field or merely field will represent the magnetism which actually exists in the air space of the motor in question, this being due to the resultant of the armature and field magnetising forces. (In speaking of induction motors we should say rotor and stator magnetising forces.)

The distribution of field at any instant around the air gap is best conceived as represented by the curve showing the strength of magnetic induction measured radially at all points around the air gap. In an induction motor it will therefore represent the distribution of magnetism around the rotor, being a space notion and having nothing to do with time. Thus the field distribution may be varying from instant to instant, but at any particular instant may be represented by a curve having as ordinates strength of magnetic induction (B) and as abscissæ the angle (θ) subtended at the centre by the circumferential arc between the point at which the induction is measured and any given diameter. A particular case is represented in fig. 1.

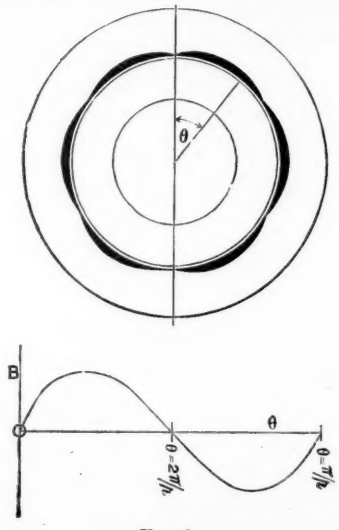


Fig. 1.

It may be assumed in the following investigations that all the poles of the motor under consideration are exactly similar, in other words, that the winding and other controlling conditions which affect the distribution of the field are similar for each pole.

Oscillating or Pulsating Field.—If we consider any distribution of field whatever, where the strength of magnetic induction alternately waxes and wanes *according to a sine law*, so that when the induction at any one point has reached the maximum it ever attains at that point the same has occurred at the same instant at every other point, and when the induction at any one point has become zero the same has happened at every other point and so on, in other words, if the strength of magnetic induction at any point and at any instant may be expressed as

$$\{f(\theta)\} \sin 2\pi n t,$$

where *t* represents the time in seconds, the field may be said to be oscillatory (or pulsating), the frequency of oscillation being *n*.

Rotating Field.—When any field distribution, while remaining intact, rotates as a whole relatively to some fixed diameter, the same will be called a rotating field.

Sinusoidal Field.—When the field distribution may be represented by the expression,

$$B = B_0 \sin \frac{p}{2} \theta,$$

it will be called a sinusoidal distribution of *p* poles, the maximum induction being B_0. A diameter along which the

* The greater part of the following paper was worked out during the latter half of the year 1894, but has remained in the shape of unpublished notes up to the present time.

air gap induction is a maximum will be called a polar diameter, and one along which the induction is zero a neutral diameter.

Waves of E.M.F. and Current.—Imagine a squirrel cage rotor immersed in a sinusoidal field, which latter rotates relatively to the former with a speed of n revolutions per second. Assume that the end rings of the rotor are so massive that each point of them may be considered at zero potential. The field in which each rotor bar will find itself will alternately wax and wane according to a sine law—and consequently an E.M.F. will be generated in each bar, which E.M.F. follows a sine law.

It also follows that the E.M.Fs. in the different rotor bars will not be in phase with one another, but at any instant the E.M.F. generated in those bars will be a maximum across which the polar diameter is passing, and will be zero in those bars lying across the neutral diameter. If we then represent the E.M.F. induced in the different bars at any instant by a curve, we see that the identical sine curve which represents the field distribution will also to some other scale represent the E.M.F. induced in the various rotor bars. Thus as the sinusoidal field sweeps round the rotor we may conceive a wave of E.M.F. sweeping round with it and being in phase with it.

The E.M.F. in each bar will give rise to a current which again will follow a sine law, but owing to the self- and mutual-induction of the various bars the current will lag behind the E.M.F. in each bar by a definite time-angle, or fraction of a complete period. It follows then that a sinusoidal field sweeping round the rotor will give rise to a sinusoidal wave of current sweeping round with the same velocity as the field, but lagging behind by a definite space-angle corresponding to the phase displacement of the current in each bar behind the E.M.F. induced in that bar. To render our ideas as concise as possible we may conceive a current wave at any instant as represented by the curve of which the ordinate at any point expresses the total current in all the rotor or stator bars per centimetre circumferential length at the point in question, while the corresponding ordinate of the E.M.F. wave denotes the E.M.F. that would be induced in a single bar if placed at the same point. The term, "wave" of current or E.M.F., is used here in a sense entirely distinct from the usual "wave form" of the E.M.F. of any supply circuit, &c., that, of course, being the way the instantaneous values of the potential difference existing at the terminals of the circuit vary from instant to instant. The notion expressed above of waves of current, E.M.F., magnetism, &c., either stationary and pulsating, or of constant magnitude and rotating, is an extremely useful one and easy to become familiar with.

In fig. 1, if we conceive the thickness of the black line at all points as representing at some given instant the current per centimetre circumferential arc in the stator or rotor bars, remembering, of course, that the crests represents alternately positive and negative currents, and then think of the whole blackened portion of the diagram rotating relatively to either rotor or stator, we get a clear idea of a wave of current sweeping round. Similarly with waves of E.M.F., magnetism, &c.

It is clear that, accepting the above definition, the combination (or call it the vector product) of a given current wave and a given E.M.F. wave represents a definite quantity of power, whereas the product of a given wave of magnetism and a given current wave represents a definite torque exerted in the rotor or stator, either of which are readily calculable.

The Analysis and Synthesis of various Magnetic Fields.—If we consider a sinusoidal field distribution as expressed by

$$B = \frac{B_0}{2} \sin \frac{p}{2} \theta,$$

and imagine this as rotating forwards with a velocity of n_1 revs. per second, and superimpose upon it another similar and equal sinusoidal field distribution rotating backwards with the same velocity, it is merely a matter of simple trigonometry to show that the strength of the resultant field at every point and at every instant is expressed by the term

$$B_0 \sin \frac{p}{2} \theta \,.\, \sin \frac{p}{2} \,.\, 2 \pi n_1 t,$$

where t represents the time in seconds.

This resultant distribution is clearly our definition of an oscillatory sinusoidal wave of p poles and frequency $\frac{p}{2} n_1$, that is to say, two equal sinusoidal field distributions rotating with equal velocities in opposite directions are identically equivalent to an oscillating sinusoidal distribution, of which the maximum is twice that of either rotatory component, and with a number of poles and frequency exactly corresponding with that of each of the rotating components.

And, similarly, the reverse must be true, that an oscillating sinusoidal field distribution may be split up into two rotating sinusoidal components, the speed of rotation giving a frequency corresponding to the frequency of oscillation.

Now, if $B = f(\theta)$ represent any field distribution whatever which is periodic as regards space, we may expand it into the form

$$B = f(\theta) = \Sigma B_i \sin (i \theta + \varepsilon_i)$$

the summation being extended to all terms obtained by giving i successive integral values between 1 and ∞.

Putting $i = 1$, we get a distribution of 2 poles
" $i = 2$, " " " 4 "
" $i = 3$, " " " 6 "
" $i = m$, " " " $2m$ "

Now the mth harmonic component of the total field $f(\theta)$ being in itself a sinusoidal distribution if oscillating with the frequency n_1 may be resolved into two rotatory components revolving at the speed of $\frac{n_1}{m}$ revs. per second.

It follows, then, that if we have an extremely complicated field distribution of p poles oscillating with a frequency of n we may resolve it into the following components:—

A sinusoidal field of p poles rotating forwards at $\frac{2n}{p}$ rev. per sec.
An equal " " p " " backwards at $\frac{2n}{p}$ "
A sinusoidal " $2p$ " " forwards at $\frac{n}{p}$ "
An equal " " $2p$ " " backwards at $\frac{n}{p}$ "
A sinusoidal " $3p$ " " forwards at $\frac{2}{3}\frac{n}{p}$ "
An equal " " $3p$ " " backwards at $\frac{2}{3}\frac{n}{p}$ "
and so on.

These harmonic fields play an important part in the theory of the single-phase motor, and account for the fact that such motors have a tendency to run sometimes at sub-multiples of their true speed. In the same way we arrive at the conclusion that a complicated field distribution of p poles rotating forwards or backwards may be decomposed into a series of sinusoidal fields of p, $2p$, $3p$, &c., poles, all rotating in the same direction with the same velocity. They would in this case induce in a given coil currents of various frequencies corresponding to the various numbers of poles of the component fields.

We have, in short, that however complicated a magnetic field may exist in the air gap, and however it may vary from point to point or from instant to instant, as long as it is periodic with respect to space and time it may be approximately imitated by adding together a sufficient number of sinusoidal fields of suitable number of poles, rotating either forwards or backwards with suitable velocities.

There are a few more well-known points which will be referred to afterwards, the proof of which being merely trigonometric it is unnecessary to append here. They are:—

(*a*) Two or more sinusoidal waves of the same number of poles and same frequency give the same resultant as would be obtained by taking the resultant of the vectors representing the waves.

(*b*) If in a given circuit there be two currents superimposed of different frequencies, the total loss due to ohmic resistance is the same as that obtained by adding the losses due to each calculated separately.

(*c*) The average force exerted on a rotor or stator round which any wave of current is sweeping by any rotating magnetic field distribution is zero if either the numbers of poles or the speeds of rotation of the current wave and field distribution do not coincide.

(*d*) The distribution of magneto-motive force acting radially

at all points of the air gap of an induction motor due to a sinusoidal current wave is also sinusoidal, the wave of magneto-motive force being displaced relatively to the current wave by one-quarter wave length. Hence it follows that where, as in the induction motor the magnetic resistance of the iron path is small compared with that of the air path, we may take it that a sinusoidal current wave gives rise to a sinusoidal wave of magnetism, but displaced by one-quarter wave length.

(*e*) If in fig. 2 E and C be two vectors representing oscillating waves of E.M.F. and current respectively, their axes corresponding but their phases differing by the time

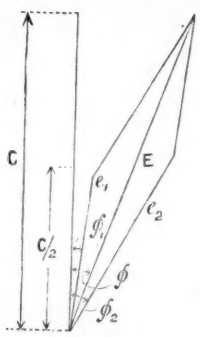


Fig. 2.

angle, ϕ, the power represented by their vector product will be, according to our definitions, equal to one-half of the power represented by their vector product if they be considered as rotating waves instead of oscillating, the angular displacement of the two waves corresponding to the time angle, ϕ.

It follows from this that if we split up E into any two components, e_1 and e_2, displaced from C by the angles, ϕ_1 and ϕ_2 respectively, the vector product [E C], E and C representing oscillating waves, is equal to the sum of the vector products of $\left[\frac{C}{2}\ e_1\right]$ and $\left[\frac{C}{2}\ e_2\right]$ considering $\frac{C}{2}$, e_1, e_2, to be rotating waves, the angular displacements between current and E.M.F. waves being ϕ_1 and ϕ_2 respectively. This principle is of importance later in the theory of the single-phase motor.

It also follows that, equating the power represented by the resultant rotating current wave in a two or three-phase motor with the sum of the powers represented by the oscillating waves of the individual phases, the magnitude of the oscillating current-wave per phase in a two-phaser, or two-thirds of the oscillating current-wave in a three-phaser must be equivalent to the magnitude of the resultant rotating current wave.

(*To be continued.*)

NOTES ON HIGHER VOLTAGE TROLLEY WIRES.

By ERNEST KILBURN SCOTT.

As the question of higher voltage on trolley wires promises to come rapidly to the front, the following notes may be interesting:—

When tramlines are pushed out so far from the power station—owing usually to the success of the undertaking—that proper feeding becomes a matter of considerable difficulty, then one or other of the following expedients has to be resorted to.

Multiple Power Plants.—This is naturally expensive and would only be justified on a line connecting several important towns, say, 20 miles apart.

Boosters.—Feeder boosters are very largely employed in the States, and they have recently been introduced on the Liverpool Overhead Railway with beneficial results.

Storage Battery Sub-stations as employed at Leeds, Isle of Man tramways, &c.

Rotary Transformer Sub-stations, three-phase and continuous as at Dublin, and on the Central London Railway, or continuous current throughout as proposed for Morecambe.

Three-wire System (continuous). — This method is under a cloud at present on account of the real or supposed difficulties in balancing.

Raising the Voltage of Trolley Lines.—This is the simplest expedient because, for example, doubling the voltage enables a given weight of copper to supply the same cars scattered over lines twice the length, and in an area four times as great.

Three-Phase Working throughout.—This system has many peculiar features, but the main advantage lies, as in all alternate current work, in the ease and cheapness of transformation from high to low voltage.

Curiously enough, it is the employment of three-phase traction at 750 volts which has brought this question of higher voltage trolley lines to the front. Messrs. Brown, Boveri & Co. proposed to use 750 volts on several three-phase railway lines, and to dispel the fears of the Swiss Railway Commission as to danger, expert advice was obtained from Messrs. Gisbert Kapp, S. P. Thompson, and H. F. Weber. An abstract of their reports is given in *L'Eclairage Electrique* for October 15th, 1898. Mr. Kapp's opinion is that the Swiss Government are not justified in insisting on a limit of 500 volts, as that voltage is as dangerous as 750; whilst from a practical standpoint 500 volts might be even more dangerous, as there is a false idea of security which does not exist. He recommends the use of circuit-breakers or fuses to guard against connections with the earth. Prof. S. P. Thompson thinks that the dangerous voltage should not be limited to 500, and he mentions a fatal case in which the voltage was only 300. His opinion is that it is a mere matter of constructive engineering to protect a trolley line up to 1,500 volts. The third expert considers high pressures perilous, but small, compared with the other dangers of high speed railroad travelling, collisions, &c., and quite justified by the advantages which might be gained.

It will be seen that the reports are practically unanimous, and when one comes to look at all the aspects of the question it is difficult to understand how any other conclusion could have been arrived at. After all 500 volts—adopted as the standard over 10 years ago—was fixed on simply as being the pressure most suited to the constructive practice of that day. With improved overhead insulating materials and more scientific controller construction, &c., the necessity for limiting the voltage has passed away. In the earlier forms of street railway motors it was difficult to get the armature insulation to withstand the dirty conditions, the jar of the gearing, and the heat; but with the development of slotted cores, Eickemeyer, and barrel forms of winding, and the introduction of micanite, &c., it is now an easier matter to build a motor for 1,000 volts than it used to be to build one for 500 volts.

Granted there is a little more risk with the higher pressure in crowded city streets, this does not apply to suburban lines, and as a matter of fact it is only on cross country lines that relief is wanted. In commenting on this matter the *Electrical World* says:—

"A system whereby the same cars could be run at high voltage in interurban and suburban work and at low voltage in the city streets. On account of the desired difference in speed the same motors might work well at 750 or 1,000 volts on suburban lines and at 500 volts on the city streets, the only difficulty being with the electric lighting of the cars, a detail which might be worth abandoning on account of the advantages to be gained. Now that four-motor equipments are coming into considerable use for heavy, long-distance service it would be a simple matter to arrange the motors in pairs, the two of each pair to be worked in series on the 1,000-volt lines and in multiple on the 500-volt lines, by means of a single throw-over switch, the two pairs to be worked together with the ordinary series parallel control."

The maximum size of trolley wires with the present overhead details and spacing of poles appears to be about ½ inch diameter for round wire and ⅞ inch by ⅜ inch for the dumb-bell pattern.* Heavier sections would necessitate the poles

* No. 0 B. & S. gauge ·3248 diameter, and No. 000 ·4096 diameter rolled into dumb-bell shape, are the sizes most used in America.

and span wires being closer together. In railway working, where large amounts of energy have to be transferred from the trolley wires to the motor terminals, it is conceivable that there would be less danger by employing a light and easily secured trolley line at 750 or 1,000 volts than a very weighty conductor at the lower pressure.

By distributing the power over more conductors, three-phase traction tends to keep the area of each conductor within limits, but, on the other hand, there is greater danger in carrying out repairs, &c., because there are two conductors running parallel to each other with the full voltage between them.

An important feature is the question of how the authorities look at this matter of high voltage, especially for alternating current traction.

In a memorandum the writer has received from the Board of Trade offices, Major Cardew says:—"No regulations for the use of multiphase alternating current with overhead trolley wires have yet been made, no such system having been proposed. The limits adopted by the Board of Trade after very careful consideration, for electrical pressure on bare overhead wires, are 500 volts continuous and 250 volts alternating, and these limits cannot be varied in individual cases, whether for traction or lighting."

Here, then, we have a healthy looking stop gap which, sooner or later, electrical engineers will have to shoulder out of the way or else get left more hopelessly behind than ever. What with one thing and another, the great molly-coddled B.P. as represented in the Lighting Acts and Regulations, have a great deal to answer for. In all engineering matters we at one time led the world, and what is perhaps more to the point, picked up the plums, but now it is to be feared that through over-regulation we are developing into mere copyists and not so good as the Japs at that.

It may be interesting to note that in Switzerland the Stansstad-Engelberg line, 14 miles of track now working, and the Burgdorf-Thun line, 25 miles of track nearly completed, have 750 volts three-phase current on the overhead trolley wires.

A TWO-SPEED TRAVELLING ELECTRICAL PLATFORM.

It is known that by order of the Minister of Commerce and Industry a competition has been opened for the construction and working of a railway and moving platform for electrical traction for the Paris Exhibition of 1900.

The committee charged to examine the various projects submitted selected that of M. de Mocomble. The single line of railway proposed would convey passengers from the Esplanade des Invalides to the Champ de Mars, and the platform with two speeds would effect the return journey. In M. de Mocomble's plan the two zones of the platform, which travel at different speeds, are independent of one another. Each is drawn by a single rail, jointed at every 4 metres, and worked by separate pulleys fixed on metal supports. These pulleys undergo no lateral displacement, and have a slight vertical play, which enables them to regulate the adherence to the rail. The motors are fixed like the pulleys.

In June, 1898, at the time of the examination of the projects, the committee requested M. de Mocomble to be prepared in six months' time to try this platform on a closed circuit of 303 to 350 metres.

These trials have just taken place, and we have had an opportunity of seeing the platform working on a piece of ground running parallel with the Seine near the Quai de Clichy, not far from the station of the Quai de la Seine at St. Ouen les docks.

At the periphery of a large circle, about 300 metres in diameter, are raised scaffoldings, having at the upper part on the sides two grooves for the passage of ordinary wheels, and in the centre a free space.

The platform, formed of jointed sections, has underneath it an axle furnished with two wheels, which roll in the space above mentioned.

In the centre is the single rail, which rolls on pulleys which are placed at intervals, and to which a rotary movement is imparted by a method we shall presently describe. Below this platform, and branching out from the side is a second, having underneath it a jointed rail, which rolls on pulleys of a smaller diameter than the first.

In short, the principle is a rolling track, which is set in motion by pulleys placed beneath it, and worked by a continuous movement.

The pulleys for the central rail of the main platform are worked through gearing by an electro-motor. The axle which supports this large pulley supports in a prolongation another pulley of smaller diameter, placed beneath the rail of the second platform. It follows that the same motor sets the two platforms in motion at different speeds.

The first platform moves at a speed of 8 kilometres an hour, and the second at a speed of 4 kilometres. The electro-motors are of the triphased current type, fed by the company for the transmission of power which is in the vicinity. These motors, which were 28 in number at the trial in question, are connected four in series on a difference of potential of about 212 volts.

The frequency of the currents used is 25 periods per second.

The starting offers some peculiarity. All the motors are first charged, steam being then got up gradually so as to attain slowly to the normal speed.

These trials were completely successful; at the Exhibition of 1900, therefore, we shall have an interesting moving platform.

THE LATEST SUBMARINE BOATS.

English naval authorities treat the stories respecting the wonderful performances of the new French submarine boat, *Gustave Zède*, which is to prove more than a match for our stoutest ironclad, as "un affaire pour rire." All the facts about her and the six sister-craft that are to be forthwith built in French yards are already known to the Admiralty Intelligence Department. Submarine craft are ordinarily the resort of sea powers that feel their weakness. Such steamers have been designed again and again any time these past 50 years. During the American Civil War both North and South built such vessels. Ericssen, the famous engineer, tried his hand at them. They usually fulfilled one function of a submarine boat, and no more, namely, they dived to the bottom. But they stayed there, and drowned their crews. The more fortunate craft found nobody who cared to adventure upon them, and so were laid by to rot. There are few navy yards at home or abroad where types of discarded submarine boats are not more or less familiar to the officials.

A very novel type of submarine boat has recently been tested in America. It is the invention of Mr. Simon Lake, who calls it the *Argonaut*. Not only can this vessel navigate the surface of the ocean but it can *crawl* along over its bottom, and the *Argonaut* has already travelled over 1,500 miles during the past year under her own power in all sorts of weather while cruising on the surface, and over all kinds of bottom whilst submerged. Our contemporary, the *Electrical Review*, of New York, states that she has completely proved the practicability of vessels of her type as to seaworthiness, habitableness, and navigability, when submerged.

In all previous submarine vessels the attempt has been made to navigate between the surface of the water and the bottom, but the difficulties of navigation in this manner are much akin to those met with in aerial navigation. It is necessary to maintain a perfect equilibrium and trim, for submarine currents are as erratic as aerial currents and tend to affect the course of the submerged vessel, and the wave motion also tends to destroy both trim and equilibrium. Most of these vessels are designed to dive like a porpoise, and then be controlled by vertical and horizontal rudders, or vanes placed on the sides to regulate their depth of submergence. The *Argonaut*, however, is designed to travel on the surface of the water and on the bottom, for the inventor considers that such boats will only be useful near the coasts where the depths are not as a rule so great but that travelling on the bottom direct is practicable. For this apparatus two

driving wheels are provided, whilst there is a third wheel for guiding purposes journaled in the rudder.

The *Argonaut* has travelled over bottoms so soft that the divers, when leaving the boat, would sink nearly up to their waist in mud, yet she was so nearly buoyant that the wheels did not bury over six inches. She has run up and down steep hills and across dredged channels. She will climb over any obstructions she can get her nose over, owing to the fact that she is so very buoyant.

A submarine boat naturally provides many opportunities for the exercise of the ingenuity of the electrical engineer. The boat which has been most successful is propelled with the aid of a gasolene engine, but this will only be used in vessels designed for peace purposes. In vessels designed for war, where it is not desirable to give any indications of the presence of the boat, storage batteries are used. The *Argonaut* is divided into four compartments. One is called the living room, in which are placed the engine and all the machinery. There is also a diver's room with a door opening outwardly in the bottom; also an air lock and a forward lookout compartment. The machinery consists, in addition to the engine, of a 3-kw. dynamo for lighting the interior, and also to run the 4,000 C P. search light placed in the extreme bow (which is used for the purpose of lighting up a pathway in front of the vessel as the boat is rolling along over the bottom); a power and hand compressor for charging the compressed air reservoirs, and supplying air to the divers; power and hand water ballast pumps; and power and hand hoisting apparatus for lifting the two heavy down-haul weights of anchors.

Vessels of the *Argonaut* type may probably have a limited use in times of war, but are capable of being used for various commercial purposes, the principal of these being the recovery of cargoes from sunken vessels, pearl and sponge fishing, laying of submarine foundations, &c. There is no doubt that, owing to the many successful trials of the *Argonaut* during the past year, it may be assumed that submarine navigation has now passed beyond the experimental stage, and that the next few years will see many of these amphibious craft at work.

As for the French submarine boats which are designed to annihilate hostile navies in general, and the British navy in particular, we doubt whether these need be seriously considered. The submarine torpedo boat which is just as handy under water as a floating craft, still exists only in the imaginative writings of Jules Verne. Some means have yet to be devised which will dispense with the necessity of their frequently disclosing their presence at the surface in order to get their bearings; whilst the range of power, increase of speed, escape from detection by the unerring microphone, or by a swarm of small craft on the lookout, remains to be dealt with. The French craft can only cover a distance of 50 miles before it is necessary to return to the station for charging the storage batteries, and their speed below water is not more than six miles an hour. A fleet in motion would be inaccessible, and a steam launch colliding with the submarine boat, or a charge of gun-cotton burst underneath the water, even within a wide area of the craft, would send her to the bottom. Meanwhile, the French boats have not as yet been as successful as the Spanish one, of which, not so long ago, much was written. With this boat the Spaniards actually torpedoed a hulk, but the submarine boat itself has ever since been "on the stocks."

THE A B C ARC LAMP.

THE A B C arc lamp for direct or alternating current is claimed to be the cheapest and most reliable arc lamp in the market, and the simplest in construction ever introduced. It can be used for series or parallel lighting, and is absolutely self-adjusting.

It cannot well get out of order, as there is no clockwork, brake arrangement, or mechanical device brought into action.

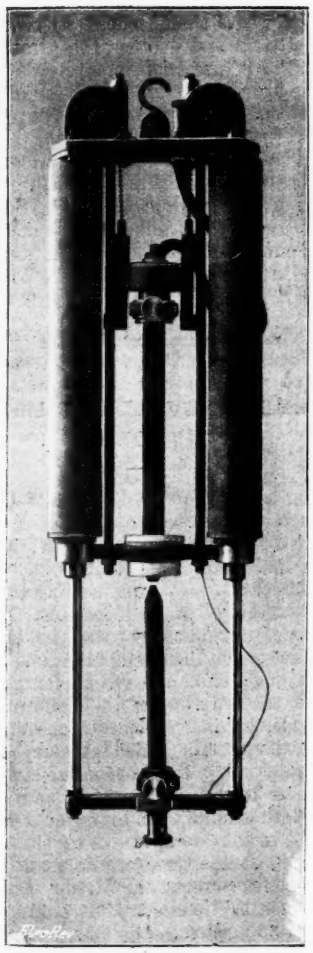
In combination with the A B C mantle the duration of the burning of the carbons is, for equal length of the body of the lamp and of the carbons, said to be equal to twice that of any other lamp.

The lamp can be adapted for long runs (100 and 150 hours) without having to enclose the arc.

The principal advantages claimed for the lamp are as follows:—Cheapness and simplicity of construction; adaptability to all circumstances and uses; total absence of mechanism; instantaneous striking of the arc; absolute steadiness of the light; impossibility of extinction; great efficiency of candle-power per unit of current; saving in carbon (45 per cent.); increase of light (20 to 30 per cent.); long burning, and consequent saving of labour.

The A B C incandescent mantle or block is composed of a patented chemical material. It surrounds the burning arc of the lamp, and may be enclosed in a small opal glass globe. The mantle increases the lighting power of the arc by 30 per cent., that is to say, it saves about one-third in current, and increases the life of the carbons by 50 per cent. The globe is fixed by a bayonet catch to the A B C mantle holder, which forms part of the A B C arc lamp.

The mantle can, by means of an appropriate holder, be applied to any other system of arc lamps. The cost of the mantle, with its holder and globe, is very trifling, and can readily be sold for from 4s. to 5s.



THE A.B.C. LAMP.

The mantle is rendered incandescent by the burning arc, gives a very powerful increase of luminosity, diffuses the light regularly, and attenuates the shadows considerably, whilst securing absolute steadiness.

The chemical composition of the mantle is calculated to give a much more cheerful and a much warmer light than that of the naked arc, and combines the power of the arc with the softness of the incandescent lamps.

The mantle is said to be unalterable, and to resist the highest temperatures.

The frame of the A B C shunt lamp is composed of two brass tubes, the extremities of which are provided with flanges of the same metal, and these are fixed to two cross pieces. Each of these tubes is surrounded by a coil or solenoid. Each of the solenoids is encased in a wrought-iron shield, which itself is closed at each end by an iron washer. (See diagram.)

The upper cross piece or plate is provided with two grooved pulleys, the outer edges of which are notched. Two small hangers or pawls engage into these notches, their play in a vertical direction being rendered adjustable by two set screws immediately above the pawls.

The pulleys and pawls are so arranged as to allow the former to rotate freely in one direction, but only to the

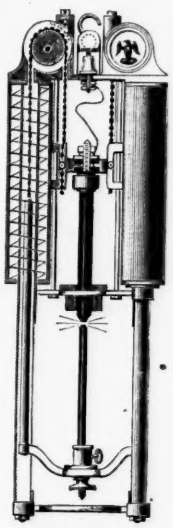


Diagram.

extent determined by the position of the adjusting screws in the opposite direction.

Two flexible chains or metal cords, as the case may be, run in the grooved pulleys. The upper carbon holder, which is electrically insulated from the frame and connected by means of a flexible lead to the inlet terminal of the lamp, is made fast to one end of these chains, whilst their other ends, attached to two wrought-iron tubes or cores, freely work up and down inside the brass tubes on which the solenoids are wound.

The lower ends of these iron cores are fixed into a wrought-iron cross-piece, on which the lower carbon holder is fixed, and the latter is electrically connected with the frame of the lamp, by means of a flexible lead, to the outgoing terminal.

The respective weights of the upper carbon holder, with its chains, and of the lower carbon holder, with its iron cores, and iron cross-piece, or yoke, are so calculated that the latter are heavier than the former, and the length of the chains and cores respectively are so adjusted as to allow the upper extremity of the cores to slightly engage in the solenoids, when the upper carbon holder is at its highest, the lower holder then being at its lowest.

As will be readily understood from this description, the mechanical arrangement of the lamp is simplicity itself. The lower carbon holder acts as motive power, and tends to always keep the carbons apart from each other, whilst the pawls, the position of which is adjustable, prevents this from taking place, except to the desired extent.

The above-mentioned external shield is one of the great features of the lamp, and is absolutely essential to the regular working of the same. Its object is to enclose the lines of magnetic forces, and to equalise the same, and consequently to insure the homogeneity of the attraction from the very moment when the iron cores enter the said solenoids, and throughout the burning of the lamp.

The second, and not less important device, is the wrought-iron cross-piece or yoke at the lower extremity of the iron cores, which forms with the latter a horse-shoe magnet, the effect of which is to form poles of opposite denomination at the upper end of the cores, and in this way (the coils of the solenoids being wound accordingly) the maximum power of attraction of each solenoid in respect of the core working therein is obtained and rendered constant, whatever may be the respective positions of the same.

It is owing to this combination of means that the A B C lamp works with regularity, forming, as it does, an electro-magnetic balance.

Let us suppose that the carbons are apart, this being always the case before the current has been turned on, as a result of the excess of weight of the lower over the upper carbon holder.

When the current is turned on, it will, passing entirely through the solenoids, since the carbons are not in contact, strongly attract the iron cores, causing the lower carbon to rise, and will allow the upper carbon to fall, thus making them to come into contact.

Immediately on the carbons coming into contact, the magnetisation of the solenoids, which are shunt wound, is reduced considerably, and the lower carbon holder, acting by its excess of weight, pulls the carbons asunder, the arc thus striking. This recoil of the carbons, and consequently the length of the arc, is regulated and determined once and for all by the position of the pawls in respect of the notched pulleys.

From that moment onward, and throughout the burning of the lamp, the pawls cease to act, and would only come into play in the event of an accidental breaking or chipping of one of the carbons. The direct magnetic attraction of the solenoids on the cores creates and maintains a perfect equilibrium, and counteracts the excess of weight of the lower over the upper carbon holder.

So effective is this arrangement that the distance between the extremities of the carbons is maintained absolutely constant, and the arc consequently perfectly steady throughout the life of the carbons with a variation of potential of only 2 volts at the terminals of the lamp.

The regulating of the lamp is extremely simple, and is effected by weighting the lower carbon, more or less, according to the voltage of the electric circuit.

Mr. G. A. Grindle, general manager of the Chloride Electrical Storage Syndicate, reports as follows :—

On receipt the lamps were unpacked, hung up, carboned, and put on a general 100-volt circuit in common with other lamps, motors, &c. The lamps burned right away without any hitch or requiring any adjustment, until the carbons were completely burnt out.

The lamps, therefore, being in good working order, a careful test was next made, the result of same taken from careful readings recorded every five minutes is as follows:—

Nos.	Polarity.	Before.		After.		Consumed.		Details of current.		
		Length in mm.	Weight in grammes.	Length in mm.	Weight in grammes.	In mm.	In grammes.	Amperes.	Mean volts.	Watts.
1	Positive	163	35·0	50	9·5	113	25·5	5·48	38·2	209
	Negativ.	146	14·5	34	3·0	112	11·5			
2	Positive	156	33 5	47	9·4	109	24·1	5·48	38 2	209
	Negative	147	14·5	40	3·6	107	10·9			

Duration of test, 9 hours 10 minutes. Positive carbons 15 mm. in diameter. Negative carbons 10 mm. in diameter.

The burning of the lamps left nothing to be desired, being remarkably steady, and the length of arc uniformly maintained.

I subsequently received from you four lamps of the same make, two of which were fitted with mantles to protect the carbons and decrease the amount consumed.

Two tests were made of these; first the two lamps without mantles were run in series off the 100-volt circuit, and the two with mantles in series; the results of these tests are given below, Nos. 1 and 2 being the lamps fitted with mantles, and Nos. 3 and 4 without mantles. In the second test one lamp with, and one lamp without, were run in each series. Nos. 5 and 7 gives the results of lamps fitted with mantles, Nos. 6 and 8 those without.

Steadiness of running.—Four tests were made for steadiness of running, viz.:—

A and B in series on a 100-volt circuit with resistance.
C and D " " " "
F, G and H " " " choking coil.
E alone on a 100-volt circuit with resistance.

Nos.	Polarity.	Before.		After.		Consumed.		Duration hours.	Details of current.		
		Length in mm.	Weight in grammes.	Length in mm.	Weight M.	Metres.	Grammes.		Amperes.	Mean volts.	Watts.
1	Positive	170	38·428	112	24·950	58	13·578	7·8	5·56	37	205
	Negative	165	23·273	122	17·030	43	6·243				
2	Positive	170	38·876	111	25·200	59	13·676	7·8	5·56	37	205
	Negative	155	22·043	106	14·660	49	7·383				
3	Positive	170	38·928	65	14·180	105	24·748	7·8	5·94	37·5	222
	Negative	157	22·748	85	12·105	72	10·643				
4	Positive	170	38·707	64	13·600	106	25·107	7·8	5·94	37·5	222
	Negative	157	23·078	90	12·650	67	10·428				
5	Positive	168	37·437	103	24·000	65	13·437	8·0	5·91	39·4	233
	Negative	163	23·397	115	16·290	48	7·107				
6	Positive	169	38·667	55	11·750	114	26·917	8·0	5·91	39·4	233
	Negative	146	20·857	72	9·900	74	10·957				
7	Positive	166	39·917	115	27·100	51	12·817	8·0	6·17	38·1	235
	Negative	150	27·447	109	19·800	41	7·647				
8	Positive	170	40·897	53	12·48	114	28·417	8·0	6·17	38·1	235
	Negative	148	25·727	83	13·96	65	11·867				

From these tests it will be seen that a very marked saving in carbon occurs in all the cases in which the protecting mantles are employed (the positive carbons in all cases being of the same diameter, as also the negative).

Taking tests Nos. 5, 6, 7 and 8, in which the current passed alike in quantity through both lamps, and in which the mean watts are practically identical, the saving in weight of carbon consumed, it will be seen is slightly over 46 per cent.

The employment of the mantle in no way affects the action or working of the lamp, and the incandescence of the under surface undoubtedly adds considerably to the amount of light obtained in a downward direction.

The burning of the lamps was extremely satisfactory, the steadiness of the arc being very marked.

In general I consider the lamp fully up to the claims made for it—light, strong, simple, free from clockwork or clutches of any description, and a lamp in which jamming of the carbons is practically impossible. The absence of delicate or working parts promises a lasting lamp, with little or no cost for repairs.

The mantle is undoubtedly a valuable invention for reducing the consumption of carbon.

The Electrical Standardising, Training, and Testing Institution, Faraday House, has also given a report upon eight arc lamps, which we reproduce:—

We have tested the eight arc lamps, and beg to report as follows:—

We have marked the lamps as under—

A, B } Large size, direct current.
C, D } Small size, " "
E Large size, " "
F, G, H } Large size, alternating current.

TABLE I.

	Maximum.	Minimum.	Mean.
Total time 6·5 hours—			
Potential difference of supply	105·7	103·8	104·4 volts.
" " on lamp A	39	29	35·5 "
" " " B	39	22	35·4 "
Current	9·4	4·1	5·8 amps.
Total time 3·5 hours—			
Potential difference of supply	105·1	103·8	104·5 volts.
" " on lamp C	39	32	35·7 "
" " " D	38	32	34·7 "
Current	4·4	2·5	3·1 amps.
Total time 6·4 hours—			
Potential difference of supply	106·6	102·8	105·0 volts.
" " on lamp E	41	31	36·6 "
Current	10·5	8·2	9·2 amps.
Total time 4 hours—			
Potential difference of supply	103·0	99·5	101·0 volts.
" " on lamp F	27·5	18	22·3 "
" " " G	33	19	26·4 "
" " " H	26	21	23·1 "
Current	15·7	9·4	13·0 amps.

The lamps in all cases burned steadily.

The resistance and the choking coil were used as received, and were not re-adjusted by us.

Lamps A, D, E, F and H, were furnished with a special reflecting block or mantle, while B, C and G, were without it.

The total number of hours run in each case is given in the table below.

At frequent intervals of time, readings were taken of the voltage of the supply and on each lamp, the current being observed at the same time. From these observations were deduced the results given in Table I.

In all cases the readings during the first 10 minutes after switching on have been omitted.

Striking of Arc.—In all the lamps the striking of the arc was performed quickly and well.

Consumption of Carbons.—The diameters of the carbons were approximately as follows:—

	A and B	C and D	F, G and H
Upper	16	10	11 mms.
Lower	11	8	14 "

In conjunction with the running tests, observations were also made on the rate of burning of the carbons, the results of which are shown in Tables II. and III.

TABLE II.—*Direct Current.*

——	A	B	C	D
Positive carbon	0·8	1·1	1·6	0·8 cms. per hour.
Negative "	0·8	1·0	1·3	1·0 " "
Condition	mantle	none	none	mantle

TABLE III.—*Alternating Current* (86 per second).

——	F	G	H
Upper carbon ...	1·2	2·4	1·3 cms. per hour.
Lower " ...	1·2	1·7	1·3 " "
Condition	mantle	none	mantle.

It will be seen from these numbers the addition of the reflecting block effects a considerable saving in the wear of the carbons.

Illuminating Power.—To find what effects the reflecting block had upon the light of the lamp, the candle-power was measured in a direction of 45° below the horizontal, both with and without the mantle in the same (or a similar) lamp.

Table IV. gives the results.

TABLE IV.

Lamp.	State.	Amperes.	Volts.	C.P. (at 45°.)
A	No mantle	7·1	32·3	860
B	Mantle	7·1	30·7	930
C	No mantle	4·0	32·0	275
D	Mantle	4·0	32·0	300
H	No mantle	13·5	28·0	750
H	Mantle	13·5	28·0	845

From these measurements it is evident that the use of the mantle gives a considerable increase in the illuminating power in a direction at 45° below the horizontal.

Construction.—The mechanical construction of the lamp is well designed and simple, the moving parts being few in number. We are of the opinion that the lamp could be manufactured cheaply.

The following supplementary report on the wear of carbons from the Electrical Standardising, Testing, and Training Institution may also be of interest to those of our readers who are interested in arc lamp improvements :—

In accordance with your instructions, we have made a supplementary test for the purpose of ascertaining the wear of the carbons, and beg to report as follows:—

The lamps were connected in series on a 100-volt circuit with the resistance supplied. The carbons in the two lamps were exactly similar. The lamp marked A was provided with a reflecting block, or mantle, whilst B was without this. In the table below are shown the approximate diameters of the carbons, the hours run, the mean current, and the wear of the carbons in each lamp.

	A		B	
Condition ...	with mantle		no mantle	
Carbon ...	positive	negative	positive	negative.
Diameter .	14·9	12·1	14·9	12·1 mms.
Consumption	0·55	0·575	0·825	0·75 cms. per hr.
Hours run	4·0	4·0	4·0	...
Mean current	5·6 amps.	...	5·6 amps.	...

Prof. Monnier, of the Ecole Centrale, Paris, has also reported on the lamp as under :—

The A B C lamp is an arc lamp intended to be fed by a current of constant potential.

The regulating apparatus is composed of two solenoids outwardly provided with a soft iron casing, and within these solenoids two wrought-iron cores connected by a soft iron cross bar, on which the lower carbon holder is fixed, are allowed to move freely up and down.

At the upper end of each of the cores is fixed a flexible chain, which passes over a pulley, itself fixed on to the body of the lamp, and its other extremity is attached to a cross bar guided by two vertical brass rods, and on which is fixed the upper carbon holder.

Since, owing to this disposition, the two carbon holders are made dependent on each other, and since the lower one is heavier, the two carbons are kept apart as long as the electric current is not turned on. As soon as the electric current is closed, the cores inside the solenoids are attracted, and the carbons come into contact; the magnetic current thereby becomes reduced, and owing to the excess of the weight of the lower carbon holder, the two carbons are pulled apart and the arc strikes.

The extent of the recoil movement of the carbon holders is limited by the action of the pawl and of the rachet wheel.

The length is determined by the position of the pawl, and same can be modified at will, by means of the regulating screw.

The principle of this regulator is extremely simple, and its action absolutely regular, owing to the soft iron cross-piece which connects the two cores, as by these means the horse-shoe electro-magnet, the magnetic intensity of which is practically constant, whatever its position in respect to the solenoids may be, is obtained. The fulfilment of these conditions is very important in view of the regulating, and of the fixity or steadiness of the arc.

The tests made with this lamp have confirmed in every respect the advantage of the dispositions claimed by the inventor.

The working of the lamp is absolutely satisfactory, the regulating takes place under variations of tension, from ½ to 1 volt, so that the light is regular and steady.

Incandescent Mantle.—The inventor has added to his lamp the incandescent mantle, of special composition, called the "A B C mantle."

The mantle which surrounds the lower end of the upper carbon considerably increases the light-emitting surface, and very greatly improves the colour of same; the use of this mantle also offers the advantage of increasing the life or duration of the positive carbon by approximately 50 per cent.

The A B C lamp is eminently suitable for small lamps from 2 amperes upwards, and can be made use of in, as well as out of doors. Its low price and the remarkable simplicity of its regulating mechanism, renders it available for all industrial and domestic purposes.

Finally, we append the report of Dr. Stern, engineer to the Union Elecktricitäts Gesellschaft, Berlin:—

A continuous current arc lamp with an incandescent mantle and one without such incandescent mantle were put in series with a resistance on a 110-volt circuit.

Lamp with Incandescent Mantle—

Length of positive carbon at beginning	123 millims.
" " after 5¼ hours	80 "
Diameter of positive carbon	16 "
Consumption of positive carbon ...	8,640 cubic millims.
Length of negative carbon at beginning	130 millims.
" " after 5¼ hours	83 "
Diameter of negative carbon	12·1 "
Consumption of negative carbon ...	5,400 cubic millims.

Lamp without Incandescent Mantle—

Length of positive carbon at beginning	110 millims.
" " after 5¼ hours	35 "
Diameter of positive carbon	16 "
Consumption of positive carbon ...	15,070 cubic millims.
Length of negative carbon at beginning	115 millims
" " after 5¼ hours	43 "
Diameter of negative carbon	10·1 "
Consumption of negative carbon ...	5,760 cm.
Total consumption of the lamp with incandescent mantle	2,675 cm.
Total consumption of the lamp, without incandescent mantle	3,930 cm.
Saving, due to the use of the incandescent mantle	48·4 per cent.

As shown by the above data, this saving is effected almost entirely on the positive carbon, whereas the consumption of the negative carbon is practically the same in both lamps.

The lamps were consuming 5 amperes, the regulating of the two series was not absolutely perfect, but eventually, on each of them being provided with a mantle, the regulating was quite satisfactory.

The carbons wear flat when incandescent mantles are used. No photometric tests were made.

Three alternating current arc lamps were put in series, consuming 13 amperes and 110 volts (30 volts per lamp), a choking coil having been inserted for below a periodicity of 50. Under periodicity of 42, the lights became unsteady. The lamps were alight and under test for 10 hours, and did not heat appreciably, whilst the light was steady and regular throughout.

Several other reports have been made of quite as favourable a character, but from the foregoing it will be gathered that an improvement of some value has been devised in open arc lamps. Although there are probably many types which will burn as steadily, and perhaps with a smaller variation than 2 volts, yet the increase of light where wanted, and the much slower consumption of the upper carbon, constitute *desiderata* which must be of real service in arc lighting in several respects, and the construction of the lamp is, as its name indicates, as simple as A B C. We shall watch the further developments of this lamp with much interest, and with the hope that so good a thing, if exploited in this country, will not be overloaded with an absurdly inflated capital out of all proportion to its market value.

The lamps can, we understand, be seen in operation at the offices of Mr. F. Fanta, 97, Queen Victoria Street, E.C., to whom we are indebted for the above particulars. That illustrated represents a 24-hours' arc lamp, working with 5 to 15 amperes, but a smaller one is made of a total length of 12 inches, taking a current of 3 to 5 amperes and running for eight hours. This is said to be quite a new departure, and will eventually be still more reduced in size.

CORRESPONDENCE.

Central Station Voltmeters.

In your description of the Folkestone central station in November last, you gave a brief description of a novel form of voltmeter. I think many of your readers would like a few further particulars.

Is the instrument wound with two equal and opposite coils; one connected to the bus bars, the other to the dynamo terminals?

Or are there two instruments connected respectively to the two positives and two negatives?

Why, in the case above quoted, are three voltmeters fixed?

Answers to the above will oblige.

C. B. Nixon.

Cowper-Coles's Electrolytic Cyclic Process.

I have read the letter appearing in the "Correspondence" columns of your issue dated February 3rd, signed "D. Tommasi." The statements and arguments appear to be the same as those made in a former letter by Dr. Tommasi, which I have already answered. My opinion is that a revolving cathode *per se* is not patentable, and even if it is, I used a revolving cathode similar to that described by Dr. Tommasi long before he took out his patents. If Dr. Tommasi will be

so good as to clearly state what his process is (of course, I do not wish him to divulge the secret compound which he adds to his electrolyte), I shall then be very pleased to point out to him the difference between the two processes.

As far as I can learn, Dr. Tommasi's process consists of the secret compound which he adds to the electrolyte, and the use of a revolving discoidal cathode.

Sherard Cowper-Coles.

A Last Word on Cyclic Electrolysis of Ores, &c.

I have no questions to ask Mr. Cowper-Coles, who has not refuted my criticisms, and therefore has recognised the soundness of my remarks on his cyclic electrolytic treatment of ores, and on the necessity of writing original articles.

E. Andreoli.

Heating Lamps.

I see from a notice that appeared in your last week's issue that I must congratulate Mr. Dowsing on having at length realised the fact that an ordinary incandescent lamp preferably run to look more or less like a red hot hair pin is the best and by far the cheapest electric heat radiator. It has taken him a long while to reach this conclusion, for if you will refer to my patent specification 2,161, of 1893, your own Journal for June, 1893, or to my remarks at the discussion on Mr. Crompton's lecture on cooking at the Society of Arts, on April 26th, 1895, when Mr. Dowsing was much in evidence, you will see that I have not failed to urge the matter on his attention. He has also had the advantage of experimenting with the "heating" lamps I was the first to introduce about five years ago, and of which he has bought specimens from me in the interval. These differ from his in the shape of the bulb, but they take the same number of watts, and I have used the same arguments about them to him and others, though my reasoning does not appear to have been so convincing as I hoped, if he still thinks a silicium heater will compare with a carbon filament one, especially in price. However, the important point is: Why do the public like to pay for embedding a resistance wire in enamel so that it cannot be repaired, or its resistance varied to suit circumstances, when ordinary incandescent lamps, run at a low efficiency in order to make them durable, give out the same heat for the same current consumption?

Leslie Miller.

Dublin Electrical Contractors.

Kindly allow me to correct an inaccuracy in a statement made in your issue of the 20th ult. with regard to the Dublin electrical contractors.

Though they have banded themselves together for the protection of their interests, this step was not dictated by their being "exceedingly wroth because contracts amounting to £6,000 *had* to be given to English firms." On the contrary, the Town Clerk has written to the Association informing them that the work referred to will be entrusted to the Dublin electrical contractors, who are quite satisfied with this arrangement.

J. W. Boucher,
Hon. Sec., Association of Master Electrical Contractors of Dublin.

Rotating Cathodes.

In the numbers of the Electrical Review, dated January 6th and January 13th, I find a note from Mr. Gibbings, and one signed "F," in which the writers assert that there exist prior claims to the invention of my system of rotating cathode. But the arguments brought forward by these gentlemen are too vague and indefinite for me to be able to answer them; I therefore request the authors of these notes to be kind enough to furnish me with exact references to the documents containing these so-called prior claims, so that I can refer to them with a view to answering their statements.

It seems to me very doubtful that these statements have any foundation, for, to my knowledge, no treatise on electrochemistry, or even on general electricity, has ever mentioned any apparatus similar to mine; moreover, I may remark that I was awarded for my system of electrolysis with a rotating cathode, a silver medal at the Exhibition of Antwerp in 1894.

Kindly publish this letter in the next number of the Electrical Review.

D. Tommasi.

P.S.—In the last article, by an error of translation, it was stated that, "the precipitated metal was *subjected* to the oxidising action of the bath," whereas it should have read, on the contrary, that "the precipitated metal was *abstracted* (withdrawn) from the oxidising action of the bath."

THE NERNST INCANDESCENT LAMP.

The electric, or, perhaps, we should call it electrolytic lamp, described and exhibited by Mr. Swinburne on Wednesday last at the Society, promises to create a revolution in electric lighting. Since about half the capital of electric lighting companies is invested in the distributing network of conductors, it is self-evident that any lamp which can be worked with voltages higher than those possible with the present glow lamp must bring about a great economy in electric supply and consequent reduction of cost to the consumer. The 200-volt carbon lamp appears to be the high water mark attainable in present practice, and all the practical men who took part in the discussion agreed with Mr. Swinburne that this 200-volt lamp was fragile and short lived, and consequently very uneconomical for the consumer. Nernst lamps have been worked at 200 and 400 volts, and Mr. Swinburne predicts that 1,000 volts are quite practicable. The Nernst lamp consists essentially of a thin rod of a highly refractory oxide, through which an electric current is sent when its resistance has been sufficiently reduced by the application of external heat. The oxides originally used in the Nernst lamp were oxides of magnesium or calcium, as our readers will have learnt from the short notices which have appeared in the Electrical Review for September 30th and December 30th, 1898; but now the inventor appears to prefer the rare oxides used in the Welsbach mantle, such as thoria, zirconia, yttria, &c. The lamps shown at the Society of Arts gave a light of dazzling brilliancy, approaching more nearly to that of the "Lampe Soleil" than to the present glow lamp. Mr. Swinburne, in fact, anticipates that the new lamp will compete rather with the arc lamp for street and large open space lighting, than with the carbon filament lamp for house lighting. But that this should continue to be the case we have yet to see.

Not only does the high voltage of the Nernst lamp make it a formidable rival of the carbon filament lamp, but its candle-power per watt is from twice to three times that of the incandescent lamp. The present glow lamp, if it is to last a reasonable time, requires at least 4 watts per candle-power; the Nernst lamp requires only 1½ watts, but we have yet to learn its lifetime in practice.

Mr. Siemens attempted, and judiciously, to throw cold water on the general enthusiasm displayed in the discussion by pointing out that we had yet to learn whether the cost of the Nernst lamp was less than that of the present lamp. The lamp looks simple and cheap; no vacuum bulb being required. But there is one retrograde peculiarity about the lamp; it requires to be lighted like gas, by a match or a spirit lamp, or in the larger lamps by a platinum resistance which is cut out of circuit after the lamp has lighted up. This is, of course, a considerable objection, which, however, may yet be overcome by the ingenuity of the inventor.

The Nernst lamp has evidently passed successfully through its experimental infancy, it is in its teens, and gives every promise of a vigorous adolescence; but the last stage is not yet reached, and we do not wish by any means to convey the impression that the doom of the glow lamp is sealed. To find that out we must await further developments.

LEGAL.

Electrical Construction Company *v.* Dick & Co.

In the Chancery Division of the High Court of Justice on Friday (February 3rd) before Mr. Justice Romer, Mr. Moulton, Q.C., said that in this matter he had to move for an interim injunction, but the defendants had put in an affidavit which showed there was a question to be tried. Under these circumstances he suggested that the motion should stand until the trial, with the usual undertaking on the part of the defendants to keep an account. He found that they could not deliver pleadings because the master had adjourned the summons for directions, and until after the hearing of this they could not go on. It seemed to him ridiculous in a patent action where there were particulars of breaches not to be able to deliver pleadings.

Mr. Justice Romer said that might be so, but it was not before him.

Mr. Moulton: Will you give us leave to set it down.

Mr. Justice Romer: No, I cannot do that; it must come before me in chambers.

Mr. Neville, Q.C., for the defendants, said he should object to its being set down. This was one of several actions brought in connection with the same patent. There was one against Thomson-Houston which was now pending, and so far as they could judge what the plaintiffs were trying to do was to try one of these subsidiary actions.

Mr. Justice Romer: If you object I cannot order it to be set down, and it must come on in the usual course.

White *v.* Headland's Patent Electric Storage Battery Co.

On Wednesday plaintiff appealed from a decision of the Divisional Court on the question of costs in an action heard at the Westminster County Court. Plaintiff considered that the costs should have been taxed under Scale C instead of under Scale A, he having recovered over £50.

The Court on Wednesday allowed the appeal.

BUSINESS NOTICES, &c.

Agency Notice.—The Crystal Electric Lamp and Rose and Bird, Limited, have appointed Messrs. Moores, Farrell & Co., of 26, Victoria Street, Manchester, their sole agents for Lancashire, Cheshire, North Wales, and the Isle of Man.

Annual Dinner.—The employés in Messrs. J. Stone and Co.'s electrical department held their annual dinner at the White Swan, Deptford, on 28th ult., about 40 sitting down.

Bankruptcy Proceedings.—The Official Receiver (Mr. R. T. Tatham) continued the public examination of Mr. Thomas King, electrical engineer, who has lately traded at St. Peter Street, Maidstone. The examination took place before Mr. Registrar Warner. The examination was of a prolonged character, the whole of the debtor's transactions being very complicated. Debtor had been ordered to prepare certain deficiency accounts, both as to his trading as well as profit and loss account, but this he had not done to the satisfaction of either the Registrar or the trustee, and consequently the examination was further adjourned for the presentation of amended accounts, and further details as to various figures he had set down. Debtor wished to allege that although he knew that his business at Brighton was not paying—in fact he admitted that he was insolvent so far as this business was concerned—yet he would not admit that he was aware of his insolvency in regard to the Maidstone business; in fact he said that was solvent. The case was further adjourned until Wednesday last, the debtor being ordered to prepare and file more detailed particulars as to his figures, and an amended trading and profit and loss account.

An adjourned meeting was held last Friday of the creditors of John Evelyn Liardet, engineer, 16, Hyde Park Gate, Kensington, before Mr. H. Brougham, official receiver, at the London Bankruptcy Court. The debtor is at present interested in water motors, electrical accumulators, and hydraulic apparatus for irrigation purposes, and he values his assets at sufficient to pay off all his liabilities (returned at £11,157) and leave a surplus of £13,352. He attributes his failure to inability to realise his patents to advantage. A scheme of arrangement was lodged, but it was deemed to require some amendment, and the chairman further adjourned the meeting for five weeks.

Dissolutions of Partnerships.—Messrs. E. W. Roe and E. Brown (Nottingham Electric Lighting and Engineering Company, the City Buildings, Carrington Street, Nottingham) have dissolved partnership. Debts, &c., will be attended to by Mr. Brown, who will continue the business as heretofore.

Messrs. J. T. Gent, A. W. Staveley, I. H. Parsons, and T. Hurley (Gent & Hurley, electrical engineers, 44, Belvoir Street, Leicester) have dissolved partnership as from June 30th, 1897. Debts, &c., will be attended to by T. Hurley, who will continue the business under the old style in partnership with his son T. S. Hurley.

Messrs. N. H. Edmondson and F. Barrett (Edmondson & Barrett, electrical engineers and contractors, Edward Street, Morecambe) have dissolved partnership. Mr. Edmondson will attend to debts.

Liquidation Notice.—The Single Wire Multiple Telephone Signal Company, Limited, is to wind up voluntarily, Mr. G. R. Neilson, of Winchester House, E.C., being appointed liquidator.

Belliss Engines.—Since the Belliss patent self-lubricating engine was introduced in 1890, about 1,000 sets have been constructed varying from 10 to 1,000 H.P., and these have been chiefly supplied to electric light and power stations. Frequent extensions to Messrs. Belliss's works have had to be made, and at the present moment a further large extension is in hand. The firm have just issued an installation sheet, noting the various supply stations in the kingdom in which their engines are running, and giving photographs of plant in a few cases, including an interior view of the Waterloo and City Electric Railway Station.

Brown, Boveri & Co.—A company has just been formed in Stockholm with a capital of 100,000 kroner, to be known as the Eletriska Actiebolag Holmia, to act as the Swedish agents for Messrs. Brown & Boveri, of Baden.

Calendar.—The Peckham Truck Company, of New York, &c., who are represented in this country by Messrs. R. W. Blackwell & Co., send us one of their large wall calendars for the current year. It is made up of monthly sheets, upon which are illustrations of the company's manufactures.

Catalogue.—Mr. T. M. F. Tamblyn-Watts, of Settle, Yorks, has issued an illustrated catalogue of physical apparatus, including drawing, surveying, and engineering instruments, balances and weights; also apparatus for the study of mechanics. In many cases the instruments are illustrated and prices given. The list is well arranged.

The Charge of Alleged Perjury.—Before the Recorder at the Central Criminal Court on Monday, in the case of John Limbrey Higgs, on bail, who was charged with giving false evidence upon oath authorised under the Companies Acts, 1862 and 1890, Mr. G. A. Scott (who, with Mr. Horace Avory, appeared on the part of the prosecution) said the case had been twice adjourned on the ground of the illness of a material witness. Since the last adjournment (according to the *Times* report) the witness had died. The witness's depositions were not taken formally at the police court because the witness fell ill before he signed them. On these facts the prosecution did not propose to proceed with the charge, they being of opinion that the proper course for them to take was to withdraw with the leave of the Court. He therefore asked that the recognisances of the witnesses should be discharged and that the bill should not go before the grand jury. Mr. Bartley Dennis (who, with Mr. Charles Matthews, appeared for the defence, said that the person who was dead was a most material witness, not only for the prosecution, but also for the defence. It was unfortunate for Mr. Higgs that the witness had died, because the true facts of the case could never be disclosed owing to his death. The Recorder said he thought the application was a reasonable one, and he granted it. He accordingly directed that the recognisances of the witnesses should be discharged and that the bill should not go before the grand jury. Mr. Bartley Dennis said that if the case had been thoroughly investigated there was no doubt that there would have been a complete answer to the charge. The Recorder (to Mr. Bartley Dennis): Yes. You are entitled to say that.

Commutator Bars.—Messrs. T. Bolton & Sons send out a small list dated January, 1899, of additions to stock sections of commutator bars.

To Creditors.—Creditors of the Electrical Coal Cutting Contract Corporation must send particulars of debts or claims, &c, to Mr. W. T. Goolden, 2, St. Nicholas Buildings, Newcastle-on-Tyne, liquidator, by March 24th.

Ediswan Ratchet Switch.—The Edison & Swan Company are making a new form of high voltage ratchet tumbler switch (patent) designed for use as a two-way or change-over switch. A ratchet wheel is fitted between the copper spring closers, and a ratchet actuated by the lever handle is geared to it, so that a quick make and break motion is given to the copper closers. The quick make and break motion is accelerated by a strong spring arranged to hold the closers either in the "on" or "off" position. For corridor lighting or use in bedrooms, where it is convenient to have two switches fixed controlling the same lamp, this class of switch is specially recommended.

Electric Clock.—A new electric turret clock has just been erected at the Northern Counties Railway Station, Belfast.

Electrical Progress in Italy.—La Associazione fra Escrienti Imprese Elettriche in Italia is the title of a new society which has just been formed in Florence by Signor F. Fieseler, Director of the Società Toscana per Imprese Elettriche of that city. The new society is an association of proprietors of central stations generating and distributing electrical energy.

E P.S. Batteries.—The E.P.S. Company announce an increase of 10 per cent. in all prices mentioned in their catalogue. The increase has been necessitated by the considerable advances in the prices of raw materials, especially lead, during the past few months.

The Large Power Schemes.—A conference of Urban District Councils in Lancashire is to be held in Manchester on 14th inst. to consider the advisability of opposing the Lancashire Electric Power Bill.

The Association of Municipal Corporations has sent in its objec-

tions to the Electric Power Bills, but it is not anticipated that the measures will come before the Examiner for a fortnight at least. The *Yorkshire Post* says that the pressure being put upon local members is so great, that it seems likely that practically a solid vote will be cast against the Bills by the members sitting for borough constituencies.

Lists.—Messrs. W. H. Wilcox & Co., Limited, send us a new 1899 illustrated circular of their semi-rotary pumps, double and quadruple acting, mounted and unmounted.

Messrs. Peto & Radford, Limited, of Hatton Garden, send us one of their price lists of small portable accumulators for a variety of purposes, such as cycle and carriage lamps, electric jewellery, &c.

The Electrical Company, Limited, have issued a new illustrated list of their measuring and testing instruments. Some diagrams are given showing connections of meters for alternating and three-phase currents, also wattmeters for three-phase work.

New Branches.—The Walsall Electrical Company, Limited, have opened a branch at 17a, South Castle Street, Liverpool, under the direction of H. H. Hall, A.I.E.E. They are very busy, having the following contracts in hand:—For Messrs. Lewis, Limited, Ranelagh Street, an installation comprising 3 40-unit dynamos, 76 arc lamps, 1,000 16-C.P. lamps, switchboard, &c.; for the Royal Victoria Hotel, Prestatyn, complete plant for 200 lights with accumulators; the West End Clothiers' Company, Limited, Liverpool, 100 lights; London and Midland Bank, Limited, Liverpool, 150 lights; Hotel Du Nord, Liverpool, 150 lights; J. B. Cramer & Co., Liverpool, 150 lights; People's Homes, Liverpool, 500 lights. The company has also 12 important contracts in hand at Barrow-in-Furness, including the Corporation generating station. They are installing the light at the Bootle generating station, baths, and Town Hall; and at Manchester 150 lamps are being put into Judges' Lodgings, Lancaster House, Higher Broughton, for which work Mr. Walter Leake is the consulting engineer.

The National Electric Wiring Company, Limited, have opened offices and showrooms at 19, Pitfield Street, Hoxton, N.

Messrs. Handcock & Dykes have opened a branch office at 3, St. Nicholas Buildings, Newcastle-on-Tyne, to deal with business in the North of England.

New Premises.—Mr. A. B. Blakey, A.I.E.E, has opened premises in Albert Hall, Lord Street, Southport, as an electrical engineer and contractor.

Partnership.—Messrs. J. H. Ferguson and James Carver have entered into partnership as electricians and sanitary engineers, and they will carry on business at Martin's Lane, Brechin, under the style of Messrs. J. H. Ferguson & Carver.

Sell's "Telegraphic Addresses."—We have received a copy of that serviceable publication, *Sell's Directory of Registered Telegraphic Addresses* for the year 1899. The book, which is an extremely bulky volume, gives Post Office telegraph and telephone regulations, list of subscribers to the P.O. telephone exchange system, names of telegraphic addresses arranged alphabetically, also cable and telegraph companies' announcements, as well as a host of other information of service to the commercial world. A large map of China is of special interest at the present moment.

Smoke Nuisance.—On 2nd inst. the City of London Electric Lighting Company were summoned by Inspector Grist, of St. Saviour's Board of Works, for allowing black smoke to issue from a chimney on their premises, Meredith's Wharf, Bankside. Mr. Topham said that the company had been summoned several times for a similar offence, their last conviction being in the early part of January. On the present occasion there were 10 summonses against the company, relating to various dates in January. Mr. Pasmore, for the defence, complained that the Board of Works had been too hasty in launching this batch of summonses. They commenced these proceedings five days after the last conviction, before the company could have had time to get a better quality of coal. Inspector Grist stated that the defendant company used a cheap coal, costing about 10s. a ton, whereas the Welsh coal cost 25s. By using the cheaper fuel the defendants saved something like £1,000 weekly. For the defence, it was submitted that the company were doing everything possible to prevent a nuisance. Their business was enormous; they supplied 360,000 lights of 8 candle-power each in the City, besides 600 arc street lamps. Obviously, therefore, they could not stop any of their engines. Mr. Pasmore added that the company did not burn Welsh coal, not, he would explain, because they desired to economise, but because they found it was ineffectual. They tried it once, and were summoned for allowing black smoke to issue. Eventually, says the *Times*, Mr. Slade, on the suggestion of Mr. Pasmore, consented to visit the premises, and the further hearing was adjourned for that purpose.

On Tuesday the Army and Navy Auxiliary Stores, Limited, of Francis Street, Westminster, were fined £5 and 2 guineas costs for permitting dense black smoke to issue from the shaft of their electric lighting works.

ELECTRIC LIGHTING NOTES.

Abergavenny.—Last week the Council had before it the report of a Committee on electric lighting. It was stated by the Committee that electric light would be a loss to the town rather than a profit, although an expert had reported that there would be a profit of £250 per annum, he having omitted sinking fund, site, &c. The report of the Committee was adopted, so presumably the Council will now be prepared to treat with companies.

Accrington.—Lord Kelvin's report on the proposed combined refuse destructor and electric lighting scheme says that, as a whole, his Lordship considers it to be quite satisfactory; and with the machinery and apparatus proposed, a good result ought to be obtained. He is strongly in favour of low tension continuous current, and is satisfied that with the 500-volt pressure now permitted by the Board of Trade, the Corporation will be able to cover a much larger area than that proposed at present for electric lighting, and will be able readily to extend the work of the generating station to the electrical working of the tramways. Mr. Shoolbred proposes to commence working on the two-wire system, and when the demand for electricity increases to change over to the three-wire system. This, says Lord Kelvin, can easily be done, and will lead to a perfectly satisfactory result. He thinks, however, that when the time comes for supplying the more distant outlying districts it will be found that the best and most economical plan will be to erect a new generating station to the south, and to connect it by feeder mains with the network supplied by the first station, thus causing the two stations to work together for the supply of the whole area. The use of the Horsfall destructor will, he believes, prove a valuable economy in saving coal, even when the amount of refuse to be treated only suffices to keep three or four of the six cells in active use.

Strenuous opposition to the large power schemes is to be offered by the Town Council.

Aldershot.—After a debate last week the District Council resolved not to transfer the electric lighting powers to any company, but to put down a municipal plant. The question of inviting tenders will come up later.

Amblecote.—The Amblecote Urban District Council have decided to consent to the application of the Midland Electric Corporation for Power Distribution, Limited, for a provisional order.

Bangor.—The Local Government Board has sanctioned the Council's proposal to raise a loan for the purchase of land for the erection of the necessary plant.

Bath.—The Electric Lighting Committee last week discussed the question of loans, as more money may be shortly required. There is still power to raise £4,452, but more is needed, and the subject has accordingly been referred to the Works Committee to go into probable extensions.

Batley.—It is stated that the Corporation may shortly discuss a scheme for carrying out the powers under its electric lighting order, which expires in two years, and an electric tramway scheme, covering about 4 miles of roads, may be combined with it. A sub-committee has the matter in hand at present.

Bettwsycoed.—A public meeting of ratepayers will be held to consider the terms of the Llanrwst Electric Lighting Company for lighting the village.

Blackburn.—The Council will petition against the scheme of the Lancashire Electric Power Company.

Bolton.—The Town Council will petition against the large electrical power Bills and the National Telephone Bills.

Bournemouth.—The Council has received copies of objections lodged by the Bournemouth and District Electric Supply Company and the Bournemouth and Poole Electricity Supply Company to the proposed provisional order. The Council has instructed Messrs. Lacey, Clirehugh & Sillar to report upon the condition and efficiency of the company's works.

Bradford.—Messrs. Sax, Slatter & Co., Limited, have just completed the lighting of the Empire Theatre of Varieties. The installation consists of about 900 incandescent lamps, and 10 arc lamps. Messrs. Owen Lucas & Pyke were the consulting engineers.

Brighton.—At the last meeting of the Town Council the recommendation of the Lighting Committee, that an assistant manager of the electric light works should be appointed, was discussed. It was stated that the chairman of the Committee (Councillor Dutton Briant) did not agree with the majority of his colleagues. It was pointed out that the manager (Mr. Wright) was away three days in the week.—Alderman Sir Joseph Ewart said each of the four departments was supervised by a superintendent. The consequence was that the works were carried on with automatic precision, and there was no difficulty whatever in their being conducted with the greatest possible amount of success. He therefore looked on the appointment of a deputy manager as superfluous. The work had been carried on smoothly and harmoniously without the slightest friction from its very inception up to the present moment. It had developed the talents of one of the greatest electric lighting engineers this country had seen. He was at the head of these works, and he (Sir Joseph) hoped no slight would be given to him in coming to the decision proposed, which he believed he was correct in saying, had not Mr. Wright's warm approval.—In the course of the discussion which ensued, it was denied that the proposal implied any slight to Mr. Wright, and a hope was expressed that he might remain engineer to the works for many years.—On a division, the Committee's recommendation was carried by 28 to 14.

Burslem.—A sub-committee of the Electric Lighting Committee has been appointed to make inquiries *re* electric lighting, with power to employ a consulting electrical engineer, and to visit any towns having an electric light installation.

Bury.—The Council has resolved to ask Mr. Kenyon, M.P., to strenuously oppose the various large electric power schemes. The Corporation will petition against the Lancashire Electric Power Company's Bill.

Canterbury.—The electric light was first turned on for private consumption on 3rd inst. Everything has been completed at the works, with the exception only of the refuse destructor. Current is to be supplied for the first fortnight free of charge. The School of Art, at which institution the trial was first made, has been fitted with 54 incandescent lamps. The plans of the electric light station were designed by the city surveyor (Mr. A. H. Campbell), in consultation with Mr. Robert Hammond, the consulting engineer; and the building was erected by Mr. A. J. Brewster, of Canterbury. The engine room plant is from the works of the India-rubber and Gutta-Percha Company, Silvertown; switchboard and instruments from Messrs. Crompton, of Chelmsford; cable work, by the Western Electric Company; boilers by Messrs. Taylor, of Marsden; and refuse cremator by Messrs. Beaman & Deas.

Cardiff.—Last week the Lighting Committee accepted a tender of Messrs. Chubb & Co. for extending the electricity works' buildings at a cost of £4,084. The Lighting Committee has been discussing whether to give the collector of electric light charges power to cut off the supply from consumers whose financial position he considers unsatisfactory. The Town Council has resolved to ask the Town Clerk to report on the powers of the committee in connection with the collection of electric light accounts. The estimates for the electricity department for the half-year ending September, 1899, were before the Lighting Committee last week. The total estimated expenditure for the half-year amounted to £2,313 4s. The heaviest item was that of wages at the generating station, the figure being £690. Coal charges were estimated to reach £350. The estimated revenue for the six months was put down at £3,0[illegible]7 10s. For the corresponding six months of last year the estimated expenditure was £2,250, and the actual expenditure £2,141 3s. 2d.

Colombo.—Thirty electric arc lamps have been erected in the Fort. Current is conveyed from the tramway works in Gas Work Street to Galle Buck in cables carried overhead. At Galle Buck the current is taken to a 100 horse-power motor dynamo, which transforms it from 500 voltage to 200 voltage. Messrs. Boustead carried out the contract.

Crewe.—The Council proposes to borrow £26,000 for electric lighting, and at last week's meeting Alderman Thomas complained that the Electric Light Committee were rushing through a partial scheme without giving the Council adequate information.

Crosby.—The surveyor to the District Council has been instructed to prepare a report upon the cost and practicability of lighting certain leading thoroughfares by electricity.

Dewsbury.—The Corporation are about to extend the electric lighting works. Plans have been approved for the extension of the engine room and for a new battery room.

Ealing.—The temporary electric lighting loan is to be increased from £15,000 to £20,000.

Edinburgh.—The Electric Light Committee last week, on the representation of the electrical resident engineer, resolved to recommend that provision should be made at the Dewar Place station for additional water storage at a cost of £550, as also for an extension of the storage batteries at the station at a cost of £1,500, and for repairs to existing batteries at a cost of £700. It was also resolved to recommend the acquisition of a considerable area of ground at Torphichen Street for an addition to the electric light station. The cost of the ground and properties on it is about £15,000.

Eastbourne.—At the last Council meeting Councillor Maude, proposing the adoption of the Electric Lighting Committee's proceedings, said that the Committee recommended a modified offer to be made to the company for the purchase of their undertaking, this being a slight increase of £1,549, and they proposed that the offer should be made in a slightly different form. They had proposed to give practically £20 a share, and this had been taken up as implying an offer clear of all liabilities on capital account, and it had been pointed out that, having regard to these liabilities, the offer did not quite reach that amount. The Committee, therefore, proposed to make up the deficiency, and, treating the present share capital as £25,105, that at £20 for every £10 would be £50,210. To that they would have to add £29,925, £3,401 to repay amount over expended on capital account, £2,000 compensation to officers, £4,152 for new machinery on order, making a total of £89,688, which, less depreciation and reserve funds, £6,275, left a net total of £83,413. He hoped that there would very shortly be a meeting of the shareholders, and that some conclusion would be arrived at. The proposition was agreed to.

Glasgow.—The tenders sent in for the various works in connection with the erection of the new power station in Pollokshaws Road show that the cost will be about £45,000, without machinery.

Great progress has been made of late with the fitting up of the electric power station at Port Dundas, and it is expected that the lamps along the Springburn route will be lit in the course of a day or two. The Committee have arranged that the current for lighting streets and houses, which is to be supplied in future from the new power stations, beginning with that at Port Dundas, is to be at 500 volts.

It has been remitted to the Sub-committee on Street Electric Lighting to consider and report on the electric lighting of additional main thoroughfares in the city.

Hampstead.—The remuneration of electrical engineers formed the topic of a lengthy and rather heated discussion at the last meeting of Hampstead Vestry (London). While the salary of the chief electrical engineer, Mr. Geo. H. Cottam, was increased from £450 to £550 practically unanimously, the recommendation of the committee that that of the three assistant engineers should be augmented met with much opposition. The committee thought that the increases should be in one case £20 (from £130 to £150 per annum), and in the other two, £10 (from £130 to £140 per annum). Mr. Saxby proposed as an amendment that in the first case the salary should be increased to £160; as it was, the Vestry only paid these electricians, mechanic's wages for their very responsible work. Mr. Stone seconded; in his opinion these gentlemen were the most underpaid employés of the Vestry. Members, he argued, should realise that they ought not to be paid only for the actual work they have to perform, but also for the expense of years of technical education. He (Mr. Stone) was amazed that the Vestry was able to obtain the services of such men at such low salaries. The result of this system was that at the first opportunity of a better appointment the assistant engineers left the service of the Vestry. Sir Henry Harben, chairman, in the main, agreed, and said the second in command ought to be paid well—it was a great mistake to pay one official too much and his immediate subordinate too little. Mr. Cottam (chief electrical engineer) said that the assistants each took charge of the station at stated times, worked both Saturdays and Sundays, and were entirely responsible when he was away; in fact, he would personally be extremely pleased if the amendment was carried. Eventually, Mr. Saxby's motion was lost and the original recommendations of the committee were carried. In the discussion on Mr. Cottam's remuneration, Mr. Pritchard pointed out that he had saved the Vestry thousands of pounds by doing the work of a consulting engineer and preparing the plans, &c., for an extension that would involve an outlay of £100,000.

The Board of Guardians will enter into a contract with the Vestry for the supply of electric current to the workhouse at 4d. per unit for two years.

Haslemere.—The Parish Council thinks that the Haslemere Electric Lighting Company should include a larger area in its application for a provisional order.

Hendon Asylum.—A contract has just been arranged between the Central London Sick Asylums Board and Messrs. Hampton's, of Pall Mall, for a complete electric light installation, consisting of a duplicate set of plant, accumulators, &c., to the specification prepared by the consulting engineers, Messrs. Owen Lucas and Pyke.

Islington.—The Vestry on Friday as a result of a joint report by Mr. A. Gay, the electrical engineer, and Mr. A. Towers, the treasurer, resolved to reduce the charge for public lighting as from the 1st ult. from 5d. to 3½d. per unit, and the private supply, after the charge of 7d. per unit for the first hour's consumption of the maximum supply demanded, from 6d. to 4d. In the course of the joint report the two gentlemen say:—"We are of opinion that the business is now in a sufficiently sound financial position to justify a reduction in the cost of street lighting from 5d. hitherto charged to 3½d. per unit, being a reduction upon the present price of 30 per cent. It must always be borne in mind that this charge includes not only the cost of producing electrical energy, but also the cost of carbons, trimming, attendance, repairs, maintenance, and the proportion of interest and redemption on capital properly chargeable to street lighting. . . . . We are of opinion that the sliding scale principle of charging is the correct one, and would suggest that 7d. per unit for the first hour's consumption of the maximum demand should be maintained. We suggest, however, that the charge of 6d. for the second hour should be eliminated. The revised scale would then be as follows:—7d. per unit for the first hour's consumption of the maximum supply demanded, and 4d. per unit for all current consumed after the first hour. Under this scale a customer whose consumption averages two hours per day of his maximum demand during the quarter, will obtain his electrical energy at an average of 5½d. per unit, for three hours 5d. per unit, and for four hours 4⅔d. per unit, which scale compares most favourably with all the London municipalities and companies." It was decided to adopt the scheme prepared by the engineer for the lighting of Canonbury Road and New North Road to the boundary of the parish. The cost of the works, including the provision of 31 arc lamps, was estimated at £5,200. It was resolved to present petitions against the Bills being promoted by the National Telephone Company and the County of London and Brush Provincial Electric Lighting Company.

Lambeth.—The Vestry has decided to present a petition against the Bill promoted by the County of London and Brush Provincial Electric Lighting Company for the reasons stated in a report to the Vestry by Mr. H. J. Smith, the clerk. The report states that the company in December, 1897, obtained the assent of the Vestry to lay a line across the parish so as to connect their lines in Battersea with those in Camberwell and the detached portion of Streatham.

The company agreed to pay and now do pay to the Vestry £100 per annum for the wayleave. As the effect of the Bill will be to empower the company to lay mains in any part of the parish without payment for wayleave, the Vestry clerk suggested that a petition should be presented against the Bill unless the Vestry is given an absolute veto as to the particular roads to be taken up and unless a sufficient rent is paid for the concession. At the last meeting of the Vestry this report was adopted, and Messrs. Rogers, Hawkey and Vincent were appointed to represent the Vestry at the conference convened by the Battersea Vestry to consider the proposals embodied in the company's Bill. The Parliamentary Committee announced that a letter had been received from the Board of Trade, enclosing the draft of an amended form of consent (in the form in which the Board proposed to approve it) to an extra high pressure supply being given by the London Electric Supply Corporation, together with an amended description of the system to be adopted by the corporation for the supply of energy under the orders already granted by the Board to them. The Board of Trade asked for any observations which the Vestry might wish to offer to the consent. After considering the matter, the Committee directed the clerk to write to the Board that they considered it advisable to leave the matter in the hands of the Board, the skilled advisers of whom would be able to say whether the proposed regulations were beneficial and sufficient to secure the safety of the public.

Leeds.—Among other sums to be spent by the City Council upon the Adel Reformatory School is £650 for the installation of the electric light.

Liverpool.—The City Council will oppose all the large electric power schemes. In moving the resolution Sir Thomas Hughes said that the Bills practically meant that two syndicates should get the whole power of supplying Lancashire with electricity. A great community like Liverpool had risked £800,000 upon supplying electricity, and found now that they would have to oppose two syndicates who were trying to obtain powers to come into important cities like Liverpool, Manchester, and other great centres of population to do what they liked. It almost seemed like audacity. One could have very little patience with it. The proposal was practically that these companies should have the power to break up their streets where they liked, and possibly not only to supply this community but those beyond.

Llanelly.—Last week the Property and Estate Committee discussed the electric lighting of the town, and it was said that Llanelly was paying 4s. 8d. against Cardiff's 2s. 10d. per 1,000 for 18-C.P. gas. It was agreed to instruct an expert to report on electric installation, &c.

London.—Last week the St. Olave's Guardians considered a report by Mr. Kirkland, electrical engineer, showing that a private installation would be the best way to light the Workhouse at Ladywell. The Board adopted the principle of electric lighting, and referred the matter to the Committee for consideration.

Maidstone.—Messrs. Kincaid, Waller & Manville have prepared a report on the electric lighting of Maidstone, and it will be laid before the Town Council at their next meeting a fortnight hence. They point out that the provisional order obtained nearly six years ago may at any time be in danger of revocation, and they urge the Council to keep the supply in its own hands. They give the estimate for establishing a combined dust destructor and electricity generating station. The capital expenditure is put at £36,349, and £1,287 is allowed for public arc and incandescent lamps and cable connection therewith. The annual cost of the electric lighting is put at £459, for which the town would get: 24 arc lamps (about 1,200 C.P.) burning until midnight, and 48 incandescent lamps of 32 C.P. replacing the arc lamps after midnight. As against this the present gas lighting in the same area costs £292 12s. 3d., a difference of £166 7s. 9d. in its favour. On the other hand, the annual revenue from the electric lighting, including the value of the public lighting, is estimated at £5,162 (providing for at least 12,000 private lamps of 8 C.P.), and the annual maintenance at £2,061. Thus a balance of revenue is shown of £3,101. After deducting interest and sinking fund, there remains a net profit of £1,126, presuming the charge for private consumers is 6d. per unit. A separate estimate is given of the cost of cremating the town refuse, assuming it to be about 13,000 tons per annum. This is, labour and superintendence in burning the refuse, £758, or 1s. 2d. per ton; repairs to destructor cells, £108—total, £866, which is £221 in excess of the present expenditure for the disposal of the refuse. The report expresses the confident opinion that if the Town Council embark in the undertaking, it can only result in a profitable issue.

Macclesfield.—The Town Council has decided to light the new technical school by electricity. The majority of the Council are in favour of opposing the Bill of the South Lancashire and Cheshire Electricity Company.

Marylebone.—The clerk at the last meeting of the Vestry explained that the solicitors had been successful in arranging for a postponement of action for one week in regard to the opposition of the Metropolitan Electric Supply Company to the Vestry's Bill on standing orders stage. The result was the possibility of again considering the proposals of the Electric Lighting Committee, which were discussed for a long time with some warmth. It was eventually decided, by a large majority, to omit from the Bill the clause proposing to purchase the company's system in Marylebone upon the undertaking of the company to withdraw its memorial against the measure to amend the Bill, so as not to exercise powers other than for street lighting and for public buildings until the purchase of the company's works, and to employ a firm of accountants to make a valuation of the property at a fee of 75 guineas. During the discussion Mr. Brooke-Hitching, chairman of the Electric Lighting Committee, mentioned that they had endeavoured to obtain the services of Prof. Kennedy to act jointly with Messrs. Kincaid, Waller and Manville, but that gentleman was too busy to advise the Vestry on the matter.—On the motion of Mr. T. W. Baker, it was resolved to refer to the Electric Lighting Committee to consider and report as to whether the Metropolitan Electric Supply Company are authorised by any consent of the Vestry, or by their provisional order, to lay trunk mains through Marylebone to supply the areas of other parishes, and, if desirable, to confer with the Paddington Vestry on the subject.

Mexboro'.—The Urban Council has taken the necessary steps in reference to an electric lighting order.

Newcastle (Co. Down).—It has been proposed at a meeting of the townspeople of this watering place to have the town lighted throughout with electricity, the current to be obtained from the new Railway Hotel, in Newcastle, built last year by the Belfast and Co. Down Railway Company, and which is electrically lighted throughout.

Oldham.—The Electric Light Committee is still considering the question of site for a second electric supply station. Prof. Kennedy, who had been instructed to prepare a specification and plans for the supply of an additional dynamo for the existing station, and for the erection of a new boiler-house and the supply of two Lancashire boilers, recommended that the order for the dynamo be placed with Siemens Bros, Limited, on the same terms and price as before, and also gave an approximate estimate of the cost of the extension and forwarded specifications for boilers, &c.

A sub-committee has reported to the Electric Light Committee in reference to an application from Messrs. Buckley & Prockter, Mumps, for an alteration in the charges for electric lighting. Mr. Andrew, the superintendent, prepared the following report on the subject, showing the consumption of electric energy by large consumers, a suggested scale of charges for large consumers, and the estimated reduction in receipts if the scale should be adopted:—Total amount of current supplied to private consumers during September quarter, 63,483 units; during December quarter, 153,534 units. The 217,017 units by two showed a probable consumption of, say, 434,000 units during the current year, as compared with 305,859 units last year, an increase of about 128,000 units. Of the total 434,000 units, 210,000 were taken by 30 consumers, the remaining 224,000 units being distributed among 261 consumers. The number of demand indicators fixed is 150, and during December quarter 116 benefited to the extent of £309 17s. 8d. In the remaining 34 cases consumers obtained no reduction. The rebate of £309 17s. 8d. is equal to a total reduction of 21·2 per cent. to the 116 consumers. The amount of rebate obtained by consumers of 1,000 units per quarter and upwards was in September quarter £43 15s.; December, £205 8s. 10d., or about £500 per annum. If the following scale of charges should be adopted, 14 consumers would be benefited to the extent of about £280 per annum. The remaining 16 large consumers would not be likely to adopt this scale, as they now receive greater benefits by the use of demand indicators. Suggested scale of charges for large users of electricity:—First 1,000 units and under per quarter, 4d. per unit, average price per unit 4d.; second 1,000 3½d., average price 3¾d.; third 1,000 3d., average 3¼d.; fourth 1,000 2½d., average 3¼d.; and fifth 1,000 and upwards 2d., average 3d. The committee adopted the report and made it retrospective, September 25th last being the date fixed.

Partick.—A deputation from the Town Council paid a visit to Edinburgh to inspect the electric lighting works.

Peterborough.—The Town Council have authorised the engineer to re-commence the works in Albert Place Meadow, that have been stopped for several months during the negotiations with the G.N.R. Company as to the purchase of the site.

Pontefract.—The Guardians last Saturday postponed for a month the recommendation of a committee to light the workhouse and premises electrically. It was thought that with an outlay of £1,500 there would be a saving of £100 per annum. In the meantime, the advice of a consulting engineer is to be obtained.

Poplar.—The District Board of Works will raise a loan of £79,000 for electricity works, repayable over the longest possible period.

Reigate.—The Council has agreed upon the Sandpit site for an electricity station.

Rochdale.—The Local Government Board recently held an inquiry *re* the proposed loan of £30,000 for electric lighting, and it has now asked for further information. It wished the Council to make a canvass of the town to ascertain the probable number of consumers. The Gas Committee, resenting this, has paid a visit to the Board, which is now reconsidering the matter. Some strong remarks were made in the Council meeting last week regarding the methods of the Board.

Rotherham.—A discussion took place on the electric lighting question at the last Council meeting, Councillor Gummer, chairman of the committee, stating that the Council had adopted a scheme formulated by Prof. Kennedy, whereby the whole of the principal streets of the borough would be able in the near future to have an installation of electric light. It was stated that a profit was expected at the end of the second year.

St. Helens.—The Electric Supply Tramway Committee on 1st inst. appointed Messrs. G. H. Carter and E E. Eccles to be engineers for the new electricity works of the Corporation. There were 62 applicants.

St. Pancras.—Dr. W. Smith, chairman of the Electricity Committee, informed the Vestry last week that the committee had taken all possible steps in order to supply customers in Brecknock Road, where a part of the road was under the control of the Islington Vestry. Both the Board of Trade and the Islington Vestry had been approached in reference to the matter, and the speaker mentioned that he had just received a letter from the latter authority inviting the committee to meet and discuss the question. As a result, he hoped that something would soon be done to remedy the matter. The Electricity Committee pointed out that additional arc lamps were required for the present scheme being carried out in Regent's Park Road and other streets, and on their recommendation, an expenditure of £680 for this purpose was sanctioned.

Sheffield.—The Electric Light Committee have informed the Watch Committee that they are prepared to confer as to the best method of lighting the public streets and the police station by electricity. They have also informed the Free Libraries' Committee that they are prepared to confer as to the lighting of the Free Libraries by electricity. It is intended to purchase for £1,002 a motor generator to supply direct current for the working of lifts and other similar appliances. The generator is to be in working order in four months.

The question of the electric lighting of the Town Hall and the Police Offices, has been under consideration by the Lighting Sub-Committee of the Watch Committee. They have conferred with the Electric Light Committee, and it has been decided that the vicinity of the Town Hall in Pinstone Street and New Surrey Street shall be lighted with electricity as soon as possible. To this end special standards are to be designed.

Shoreditch.—A letter from the Battersea Vestry, asking for three delegates to attend a conference to consider the Bill promoted by the County of London and Brush Company, has been referred to the Lighting Committee with power to act. The Lighting Committee stated, in connection with the cable recently decided to be ordered of the British Insulated Wire Company, that the engineer required certain of the cable to be of larger section than previously used. The section needed was '5 concentric, which the company offered to supply at 16s. 6d. per yard, and on the recommendation of the committee it was resolved to place an order with the company on that basis. Arrangements are to be made with the East London Water Company for the Vestry to be allowed to lay mains in the trenches being opened by the company in Hoxton Street at a nominal cost. Mr. H. E. Kershaw said this would save the Vestry about £1,000.

Sleaford.—The Urban Council is considering the question of substituting the electric light for gas for the public streets, and an expert is to be engaged to report.

Southport.—The Council will petition against the Bills now being promoted by the Southport Tramways Company, Limited, the Southport and Lytham Tramroad Company, the Lancashire Electric Power Company, and the South Lancashire and Cheshire Electricity Company respectively.

Sowerby Bridge.—The District Council have applied to the Board of Trade for a provisional order authorising them to supply electricity for any public or private purposes within the area of the Council's gas supply. A number of districts of urban authorities are affected, as they are within the gas supply area.

Stockport.—The Stockport Council will oppose the large electric power distribution schemes, also the National Telephone Bills and the Heaton Norris District Council's application for a provisional order.

Swansea.—The Electric Lighting Committee last week, having received sanction from the Local Government Board for the £60,000 electric lighting loan, last week had before them estimates for the proposed works, but it was resolved not to make them public at that stage.

On Monday the Committee adopted modified plans and estimates for the lighting scheme.

Village Lighting.—It is stated that the chairman of the Heacham (Norfolk) Parish Council has introduced a scheme for 14 electric lamps, which he states can be maintained at £28 per annum, and a 1d. rate will cover this. A similar scheme is intended for the neighbouring village of Snettisham.

Whitechapel.—The Board of Works has resolved to accept tenders for the performance of such work and obtaining such plant as may be necessary to proceed with the installation in the manner recommended by Mr. Wright's report.

Winchester.—The business of the Winchester Electric Light and Power Company is rapidly extending. A committee of the Town Council has just recommended in favour of the use of the electric light in the School of Art and Public Library, as well as in other parts of the municipal buildings. It is also intended to light the Congregational Church by electricity. The steam laundry, an extensive building, has just been fitted with the new illuminant, and works are in progress to carry it to some of the principal private houses on the outskirts of the city.

Worthing.—The Electric Lighting Committee have recommended that the area to be electrically lighted shall embrace the whole of the streets within the borough that are now lighted by gas, and that the Marine Parade, from Warwick Road to Heene Road, South Street, and Chapel Road to the railway station, Warwick Street, and Rowland's Road, be lighted with arc lamps of 1,000 candle-power; Brighton Road, from the Steyne to St. George's Road, Farncombe Road, Broadwater Road, Crescent Road, Heene Road to Richmond Road, Richmond Road, Shelley Road, the Steyne, Seville Road to South Farm Road, and Victoria Road, with lamps containing a single 50-candle-power incandescent light; and all the remaining streets with lamps containing two 8-candle-power incandescent lights. As to the price, the Committee were of opinion that the maximum charge to private consumers should be 6d. per unit, and the maximum charge for public lighting 2d. per unit. The Council are also recommended to authorise the engineers to complete the preliminary plans and furnish the necessary information to enable the Council to apply to the Local Government Board for sanction to a loan of £35,000, and two members of the Committee have been requested to select the several streets within which, in the first instance, they consider it desirable to lay distributing mains to supply current to private consumers.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The Great North of Scotland Railway propose putting down a short electric tramway from the Cruden Bay Hotel to Cruden Bay Station for the purposes of the hotel.

The Tramways Committee recently met to consider what system of electric traction to adopt on the Woodside route. After discussion, the Committee agreed to instruct Mr. Dyack, burgh surveyor, and Mr. Bell, electrical engineer, to bring up a report as to the mode of electric traction to be adopted on the Woodside route, and the details regarding the work. It was agreed that cars similar to the "double-deckers" in Glasgow should be constructed. The feeling of the Committee was, that the overhead system should be adopted.

Bath.—Last week the Electric Lighting Committee considered a letter received from the British Electric Traction Company, in which they put forward a scheme for providing the town with light electric railways, current being taken from the municipal electricity works. A joint committee of Electric Lighting and Surveying Committees will consider the matter.

Blackburn.—On 2nd inst., in reply to a question in the Council meeting as to the probable date for running the electric cars, it was stated that the Electricity and Tramways Committee had done all they could to expedite the matter, and had even instructed their consulting engineer to withdraw supplies, and to tell Messrs. Siemens that the Corporation would insist on payment of the penalty for not carrying out the contract within the stipulated time. Alderman Thompson did not like to make any definite promise, as they had been disappointed previously. He seemed to think it would be three months before the cars would be running.

Bristol.—The report of the directors of the Bristol Tramway Company, a considerable length of whose lines is worked electrically, shows that in the half-year ended December 31st, 12,644,476 passengers were carried in the cars and omnibuses. The gross receipts amounted to £78,258 14s. 8d., and working and general expenses and renewals to £55,806 0s. 1d. leaving a net balance of £22,452 14s. 7d. for dividends. The dividend on the ordinary shares is to be 7 per cent. per annum, free of income-tax, and a considerable sum is carried to reserve. Tramway receipts show an increase of £8,143. The report adds that fair progress has been made with the work of constructing the authorised extensions and the adaptation of existing lines and depôts for electrical operation. The site of the central power station at Counterslip has been cleared to the required extent, and the company's contractor is now engaged upon the foundations and new harbour wharf, the latter being necessary as the site fronts the river. An eligible site of five acres of land at Brislington has also been acquired for the erection of an extensive depôt and car-building works, the provision of which will enable the company to deal economically with the enlarged undertaking under the new conditions of electrical working. The St. George and Hanham Light (Electrical) Railway Order was confirmed by the Board of Trade on November 28th last, but certain formalities to satisfy further requirements of the department still delay the actual construction of the line. The report also alludes to the creation of additional capital in the shape of 25,000 new preference shares of £10 each; the interest will be 4 per cent., and the issue will bring the company's capital up to three-quarters of a million.

Crystal Palace.—A committee of the Lewisham District Board of Works has considered the plans, &c., of the proposed Crystal Palace light electric railways, which scheme the Board had already given notice to oppose. The only places of importance where the proposed system touches this district are in Penge and at the top of Anerley Hill. The Board's objections are to the special provisions which are being sought as to overhead electric power, the proposed carrying of goods as well as passengers, and the steep gradient of Anerley Hill, of which objections the committee had directed that the Light Railway Commissioners should be informed.

Dewsbury.—Last week representatives of the British Electric Traction Committee waited upon a sub-committee of the Corporation to try to persuade that body to withdraw their opposition to the company's scheme.

Dublin.—In the annual report of the Dublin Fire Brigade, Captain Purcell says:—"The general introduction of electric traction, with overhead wires in the streets, has rendered it necessary to alter our system of fire escapes and methods of working. For the present I have cut down the ladders, and reconstructed four of the escapes for use in that portion of the city where the wires already exist; they will not now reach the highest windows, and are only a temporary provision until the new pattern horizontal escapes and the stations to house them are ready. Rubber gloves for the firemen to wear when working in the vicinity of wires charged with electricity, and special insulated appliances for cutting the wires when necessary, now form portion of the equipment To meet the altered conditions, I have specially designed an aerial extension fire escape, involving some new principles of construction which have been provisionally protected in the Patent Office by permission of the Corporation. A contract for the first one has been let by your committee to William Rose & Co., Manchester, and it is now nearing completion at the contractor's works."

It is stated that the central power station of the Dublin Tramways Company will be completed by about May or June.

Dublin and Lucan.—The directors of the Dublin and Lucan Steam Tramway Company, in their report, say that they are disappointed that more rapid progress has not been made with the electrical equipment. The delay has been entirely occasioned by the difficulty in procuring a suitable site upon which to build the generating station, but one has been recently secured, and the directors anticipate that the line will be working by electricity before the next half-yearly meeting of the company.

Dundee.—A debate at the Town Council meeting last week on the tramway question ended in the passing of the following resolution:—"That the Council itself promote an extension of the tramway system with all possible speed, substantially on the lines proposed by the outside company, and remit to the Tramways Committee to consult an eminent engineer, formulate a scheme, and report forthwith."

Eccles.—The Council will petition against the Bills of the Manchester and Salford Corporations as to electric tramway traction.

Great Northern and Strand "Electric."—At a special meeting of the Great Northern Railway Company the following Bill will be submitted for approval:—"A Bill for incorporating the Great Northern and Strand Railway Company, and for empowering them to construct an underground railway from the parish of Wood Green in the county of Middlesex to the parish of Saint Clement Danes in the administrative county of London, and for other purposes." The railway, as proposed by this Bill, is to be constructed in tunnel commencing at Wood Green under the Great Northern Wood Green station, and following the line of the Great Northern Railway to King's Cross. From thence it will pass in a south-westerly direction to its southern terminus, near the junction of the new street (proposed to be constructed by the London County Council) with the Strand. The Bill contains provisions empowering this company and the Great Northern and Strand Railway Company to enter into working and other agreements. The motive power proposed is electricity. The directors believe that the undertaking (if sanctioned) will materially aid in the development of the suburban districts served by the Great Northern Railway.

Glasgow.—Last week at the meeting of the Corporation Mr. Paton moved the adoption of the Tramways Committee minutes, which bore that a sub-committee had been appointed to report fully on the question of the supply and distribution of electric power for the tramways, and with instructions to confer with a sub-committee of the Electricity Committee, and to obtain the opinion of an expert on the whole matter. Mr. Finlay thought it premature to appoint an expert. Mr. Paton said the appointment of an expert had been already settled by the Council. A reference to the minutes showed that the Committee had been empowered to consult an expert if they thought advisable. A long discussion ensued on the general question as to whether the expert's guidance was to be taken by the Tramways Sub-committee on the whole subject of the trolley, or by the Joint committee on the subject of the generation and supply of power for tramway purposes. The Lord Provost suggested as the only way out of the difficulty that the Joint committee be empowered to appoint an expert, if they thought it advisable to do so, after the conference had taken place. Mr. Paton said the Tramways Committee had to carry out a huge undertaking which would cost half a million of money. There was the question to be considered as to whether they should produce the electricity from four or five stations at 500 volts or should have a large central station producing current of 3,000 or 4,000 volts. The Tramways Committee had the whole expenditure to consider—the whole responsibility. The Electricity Committee had no responsibility whatever. The two departments might very fairly consider the question of the manner in which the electricity was to be produced. Regarding the rails, the installation, the system in which it was to be supplied, whether at 3,000 or 4,000 or 500 volts, the Electricity Committee had nothing whatever to do. The Tramways Committee had to stand or fall by what they recommended to the Town Council. If they were to do all that, surely the reasonable thing was not for the Joint Committee to have the services of an expert, but for the Tramways Committee, who had the responsibility, to have the very best guidance they could get. The appointing of an expert had nothing whatever to do with the source from which the electricity was to come. However, in view of the feeling shown by the Council, he would delete the phrase with reference to the appointment of an expert. The minutes, as amended, were approved.

Hanwell and Uxbridge.—The other day objections to the confirmation of this light railway order (promoters, London United Tramways Company) were heard by Sir Courtenay Boyle and others at the Board of Trade. The main objection seemed to be to the carriage of heavy goods, and it was ultimately arranged that the promoters and objectors should agree on clauses to meet this difficulty as to the weight of goods permissible, and submit them to the Board of Trade for confirmation.

Italy.—A Reuter telegram from Milan states that the electric railway from Milan to Monza was opened on Tuesday in the presence of the authorities and the representatives of the railway companies.

Kingston.—Proposals are being put forward from Kingston for the construction of an electric tramway joining Richmond to Kingston and the surrounding towns, to be under municipal control. The Richmond Town Council view the scheme favourably.

Leeds.—The other day, in moving the adoption of the minutes of the Tramways Committee, Mr. Smithson referred to the resolution recommending that the bonding of rails on the Beckett Street and York Road routes be completed, and that the lines be otherwise equipped for electric traction. He said that while the Committee hoped to have the electric cars running on the Headingley and Chapeltown routes by July, they would not commence on the Dewsbury route, owing to the difficulties in connection with the erection of the railway bridge. They propose, therefore, to proceed with the equipment of the Beckett Street route, and so use all the available power.

Liverpool.—The Corporation on Wednesday last week resolved to obtain tenders from those firms on the list of contractors for 20 motor cars of the same type as the 12 already ordered from the British Thomson-Houston Company, to be delivered not later than June 1st.

Mr. Rutherford, in addressing the Council, said that at present they had in stock 32 motor cars, and they had on order 12 motor cars, which were to be delivered on May 1st. They were told by the officials that it would take 36 cars to run a reasonable service on the Dingle line, as extended to Aigburth Vale, and Prince's Park line as extended to Toxteth, both of which would be completed in the early part of May. Therefore, the result would be that out of the 12 cars on order they would have eight cars free. They were to have the Smithdown Road extension complete with regard to street and overhead works in the early part of June, and they would want for that service 20 cars, therefore it was necessary to provide that 12 cars should be delivered by June 1st in order to cope with this populous district. That was on the basis of a three minutes' service, and it had been thought on reflection that that would not be adequate, and therefore they desired to increase the number from 12 to 20 cars. As they would require 300 or 400 cars for the whole city, there was no harm in ordering an extra car or two, and especially as in consequence of the delicate character of some of the machinery of the cars they got out of order and had to return to the shed. Eighteen such accidents occurred in 14 days.

Speaking later, Mr. Rutherford said that, having regard to the great activity in electric traction all over the country, the price of electric equipments was bound to go up, and they ought to take every opportunity of getting hold of all the plant that could reasonably be suggested as necessary for their service. That was why there was a considerable amount of haste. The British Thomson-Houston Company had offered to give prompt delivery of four cars, and were willing to give them prompt delivery of 12 cars. Then there was another matter in regard to litigation that caused them to go to the British Thomson-Houston Company. There was no doubt that the patents for motors and trailers were at present vested in the British Thomson-Houston Company. The Liverpool Corporation had already had one or two actions brought against them, and they must not place the Corporation in a position of being subject to law suits and injunctions when that could be done without any extra expense.

The town clerk stated that when the Corporation entered into a contract with a German firm and Messrs. Dick, Kerr & Co. to supply cars, a provision was inserted in the contract that the firms must indemnify the Corporation against any liability whatever, either for infringement of patents or payment of royalties. After those cars had been provided, and were running on the Corporation tramways, an action was commenced by the British Thomson-Houston Company against the Corporation for alleged infringement of patents. He communicated with the two firms who had supplied the cars, and they were prepared to fight the case, or, at any rate, to pay whatever damages there were. At present the position was that the British Thomson-Houston Company had not delivered their statements of claim, but he had had an intimation from them that when they had done so, they would not require the Corporation to deliver any defence or proceed further with the action until they gave notice that the Corporation were to do so, and he assumed such notice depended on the direction in which the contracts went in the future. He did not expect that any court would grant an injunction with regard to the cars that were now running.

Mr. G. Henderson asked if he was to understand that the Corporation's freedom from liability depended on their continuance of orders to the British Thomson-Houston Company.

The town clerk replied that he had not said so, but he believed that

as long as the Corporation did not order cars from the two firms alleged to have infringed the patents, the British Thomson-Houston Company would not proceed against the Corporation.

At Monday's meeting of the Tramways Committee it was resolved to invite local firms to tender for the 20 new cars required for the electric system.

The Manhattan Railroad.—A Reuter despatch from New York says that the Manhattan Elevated Railroad Company has decided to use electricity as its motive power, and to issue 18,000,000 dols. more stock for the purpose.

Middleton.—It is stated that the Council has distinctly told the Board of Trade that they were not acting in conformity with the spirit of the Light Railways Act in giving the British Electric Traction Company powers to construct a railway through the borough, and the Council is going to appeal to Parliament on the subject.

Mont Blanc.—A scheme has been drawn up by M. Saturnia, a Geneva engineer, and is at present receiving consideration, for a projected electric cable railway up Mont Blanc. The line, which is estimated to cost £400,000, would be 10 kilometres long, 3½ of which would be in a tunnel.

Perth.—The Police Commissioners have given consent to the application of the Perth and District Tramways Company for authority to use electric traction for the trams, but will not grant an extension of the lease.

Portsmouth.—The Tramways Committee have considered the report of the sub-committee who recently visited Willesden, Dover, Rouen, and Paris, for the purpose of inspecting the electric tramways there. A preliminary report, which had been prepared, was read and carefully considered, after which the Committee decided, by an absolutely unanimous vote, to recommend the Town Council to adopt the overhead system of traction for the Portsmouth electric tramways. The report is to be printed and placed in the hands of members of the Town Council as soon as possible. The Committee had under consideration a letter from the tramways company with reference to the Committee's decision to apply to the Board of Trade for the appointment of an arbitrator in respect to the purchase of the company's property. The company applied to the Committee not to make the application until after they had seen the terms asked by the vendors, and expressed a hope that the negotiations might be completed without the intervention of an arbitrator. The Committee decided to reply that they were quite willing to wait until the terms were sent in, providing the same was done speedily.

St. Helens.—The Electric Supply and Tramways Committee have been busily pushing forward the work of laying down and equipping the tramlines for electric traction. On the Prescot section the work has been stopped at Cropper's Hill for some time, owing to a request being made by the Tramways Committee that double lines should be laid in order to ensure the safety of the cars on this hill. The committee have now resolved to lay double lines. In answer to the Tramway Company, the committee have stated the order in which they will carry out the proposed extensions. The extension to the Ram's Head, Haydock, will be carried out first, and this will be followed by the extensions to Nutgrove, St. Helens Junction, Derbyshire Hill, to the boundary of Prescot, and to Windle City. The promoters of the St. Helens, Leigh, and Bolton Light Railway have undertaken to withdraw their application for powers to construct the railway in the borough, and the proposed terminus of the light railway will be at the borough boundary in Newton Road. The St. Helens and District Tramways Company has asked the committee to apply for powers to extend the proposed tramway from Derbyshire Hill to the borough boundary to meet the light railway. It was resolved, subject to the cost thereof being paid by the tramways company and the promoters of the light railway, that application be made to the Board of Trade for the necessary provisional order.

Tees-side.—Mr. J. Clifton Robinson (representing the Imperial Tramways Company) met a deputation from the South Bank-in-Normanby Urban District Council last week, regarding the proposed extension of the Tees-side electric tram system into the South Bank and Eston districts.

Twickenham Light Railways.—The Drake & Gorham Electric Pioneer Company has proposed to the London United Tramways Company, Limited, that they should combine in their applications to construct a light railway from Richmond to Twickenham, and thus meet the opposition of the Twickenham District Council and local residents. The latter company have replied refusing to enter into any such scheme.

Wednesbury.—The town clerk has been instructed to oppose the Bill of the British Electric Traction Company in respect to the South Staffordshire Tramways.

Wrexham.—The Town Council has decided to engage Mr. W. H. Trentham to advise the Council on the proposed electric lighting, refuse destructor, and electric tramways.

TELEGRAPH AND TELEPHONE NOTES.

Cutting the Manila Cable.—A Washington despatch says that the decision of Mr. J. W. Griggs, Attorney-General, respecting the legal questions raised by the cutting of the Eastern Extension cable by Admiral Dewey at Manila has been given. He upholds the right of a military commander to cut a cable within the territorial waters of the enemy without making his country liable to damages. Mr. Griggs, therefore, finds that there is no ground for the claim for damages made by the Eastern Extension Telegraph Company against the United States Government.

Direct Continental Landline.—The laying of a new copper telegraph wire between Paris and Bordeaux for the Franco-Spanish Service has just been completed. It is understood that the new line will be connected with the Cadiz wire, thus forming direct communication between Paris and Cadiz. It is thought that this new wire will have special importance, because the Teneriffe line which serves the West Coast of Africa and South America starts from Cadiz.

German Cable Enterprise.—We understand that the Sultan has granted to Dr. Zander, director-general of the Anatolian Railway, who is connected with the Deutsche Bank, a concession to lay a cable between Constantinople and Kustendjeh or (Cuistanza) on the Black Sea coast of Roumania. This cable, which will be a little over 200 miles in length, will render communication between Berlin and Constantinople *viâ* Bucharest more secure, and is reported to be the first link in a system which has for its object the establishment of an independent telegraph line to the East *viâ* Fao. To render such a line efficacious it will be necessary that the control of the Turkish landline, which runs along the Euphrates valley, should be handed over to Germany so that it may be put into working shape. Although, in the first instance, the scheme now initiated has for its object the establishment of a line to the East under German control, still the British community will benefit in so far as such a line will, when under good management, afford an alternative route to India in competition with the present joint-purse combination between the Indo-European and the Eastern Telegraph Companies, which persistently refuses to heed the demand so generally made for a reduction of rates to India. The German Emperor has shown the interest which he takes in the subject by telegraphing to the Sultan his thanks for the concession granted to German subjects. We learn that in another direction active steps are being taken to secure for Germany an Atlantic cable route which will be independent of English landing places. We have frequently pointed out that the cable which runs from Emden to Vigo, although its existence is due to a great extent to English capital, meets the condition of avoiding an English landing place. The cable from Lisbon to the Azores having served the purposes of the English companies by which it was laid, can be connected with the Emden-Vigo cable, and it only remains to continue the line from the Azores to the United States to establish, if necessary, with the help of American capital, a line which will meet the required conditions. At the recent meeting of the Anglo-American Telegraph Company, the chairman pointed out that a German cable was not needed as far as the traffic-carrying capacity of the existing cables is concerned, but the German Government seems to be determined, and wisely enough, we think, from their point of view, to establish lines both east and west, by means of which the control of telegraphic communication shall lie as little as possible in the hands of foreigners.

German Submarine Cables.—The *Standard* Berlin correspondent says that the German Government is endeavouring to extend its system of submarine cables, in order to be independent of foreign lines. Germany has now only two such cables—one, that to Spain, has a length of 2,064 kilometres, and was laid at a cost of 3½ million marks. It does not touch England or France, but is connected with the trans-Oceanic cables to South America, Africa, Eastern Asia, and Australia. The second runs from Emden to Valentia, in Ireland. A joint stock company, with a capital of 20 million marks, is now being formed at Cologne for the extension of the German submarine cable system.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
Para-Maranham	Nov. 14th, 1898 ...	Feb. 4th, 1899.
Landlines.		
Saigon-Bangkok	Feb. 2nd, 1899 ...	Feb. 2nd, 1899.
Lines near La Paz, Bolivia	Feb. 1st, 1899 ...	...
Communication with interior Madagascar (temporary)	Feb. 5th, 1899 ...	...

The Telephone Question.—Reading Council is petitioning for Government control, and will oppose the National Company's Bills.

The National Company is circulating a reprint of the *Times* articles on "The Telephone Service," to which we have already alluded at length. The circular contains an appendix compiled by the company, showing the progress of the company's undertaking since the amalgamation of the companies in 1889.

The Altrincham Urban District Council will present a petition against the National Telephone Company's Bill.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—February 23rd. The Electric Committee wants tenders for water-tube boiler, two steam dynamos, and switchboard. See our "Official Notices" February 3rd.

Canterbury.—February 15th. Tenders are being invited for the supply of coal to the electricity works during ensuing year for the Lighting Committee. The quantity of coal likely to be consumed is estimated at about 300 tons.

Christiania.—February 26th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Administration for the delivery of about 140,400 porcelain telegraph and telephone insulators. Tenders must be received at Christiania by 12 o'clock noon on February 26th, 1899. A copy of the specification, conditions, &c., may be examined on personal application at the Commercial Department of the Foreign Office any day, between the hours of 11 a.m. and 5 p.m.

Edinburgh.—February 20th. The Council wants tenders for overhead travelling crane and storage batteries. See our "Official Notices" February 3rd.

Edinburgh.—February 27th. The Council want tenders for steam, exhaust, feed, and drain pipes, feed pumps and tanks. See "Official Notices" this week.

France.—February 16th. The French Post and Telegraph authorities in Paris are inviting tenders for the supply of 46 kilometres of gutta-percha insulated electric cable. Particulars may be obtained from, and tenders to be sent to, Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Gloucester.—The City Council wants tenders for jet condensers, air pumps, cast-iron pipes, &c., for the electricity works. See our "Official Notices" February 3rd.

Islington.—February 23rd. The Vestry invites tenders for the supply of electrical and engineers' stores for one year from March 25th. Particulars, &c., are obtainable from the Vestry Hall, Upper Street, N.

Italy.—February 25th. Tenders are being invited by the municipal authorities of San Severa (Province of Foggia), for the electric lighting of the town. Tenders are to be sent to Il Municipio di San Severa (Foggia), Italy, from whence particulars may be obtained.

Kingston-upon-Thames.—February 14th. Tenders are being invited for the provision of telephonic communication between the various buildings upon the workhouse premises, Kingston-on-Thames, for the Guardians. Particulars of the architect, Mr. W. H. Hope, Union Offices, Kingston.

Manchester.—February 20th. The Corporation wants tenders for the supply of sample electric tramcars. See our "Official Notices" this week.

Nelson (Lancs.).—February 14th. Tenders are being invited for the supply and erection of the following plant, for the Gas Committee:—(Section A) steam dynamo, ejector condensers, &c.; (B) switchboard; (C) alterations to accumulators; (D) overhead crane. Particulars to be obtained at the office of the engineer, Mr. Wm. Foster, Nelson, Lancs., on the deposit of £2 2s., which will be returned on the receipt of a *bonâ fide* tender.

Norway.—February 11th. Tenders are being invited by the Norwegian Telegraph Authorities in Christiania for the supply of 80½ tons of telegraph wire 4 mm. diameter and 121 tons ditto 5·3 mm. diameter. Tenders to be sent to the Bureau des Telegraphen, Director Karl Johansgade, 14, Christiania, whence particulars may be obtained.

Oystermouth.—February 27th. The District Council wants tenders for the supply of electricity within the area. See our "Official Notices" February 3rd.

Southampton.—Tenders are invited for one 100-kw. engine and generator, one boiler, a set of accumulators, 20 motors, &c. See our "Official Notices" January 27th.

West Hartlepool.—February 13th. The Corporation wants tenders for feeders, mains, arc light leads, and road work. See our "Official Notices" January 27th.

CLOSED.

Glasgow.—It is stated that the Westinghouse Electric Company are to supply the motors for the Govanhill electric cars at a cost of £6,600. Messrs. Doulton & Co. are to supply the earthenware ducts.

Hereford.—The Town Council has just accepted the tender of the India-Rubber, Gutta Percha, and Telegraph Works Company, Silvertown, to carry out the installation for electric lighting of the centre of the city, at a cost of £11,231. These figures do not include the buildings, trenching, and other matters.

Leigh.—Last week the Council resolved to affix the common seal to contracts with Messrs. Mather & Platt, Limited, for the supply and fixing of steam dynamos and steam exhaust pipes for the sum of £2,874, and a water softener, £150; Chloride Electrical Storage Syndicate, Limited, for the supply and fixing of accumulators, £1,500; British Insulated Wire Company, Limited, for the supply and laying down of mains and underground work, £1,537 19s. 3d.; Messrs. Chamberlain & Hookham, Limited, for the supply of 60 meters, £304 10s.; Messrs. James Carrick & Sons, Limited, for the supply and fixing of an overhead travelling crane, £196; Dorman and Smith, switchboard, £715.

Fareham (Hants).—The *Contract Journal* gives the following list of tenders submitted for electric lighting and laundry plant for extensions at County Lunatic Asylum, Fareham. Mr. W. J. Taylor, county surveyor:—

F. Shalders, Southampton (accepted)	£4,052
Brush Electrical Engineering Company, London ..	4,630
Calvert & Co., Manchester	4,650
Bow, McLachlin & Co., Paisley	4,700
Joel & Potter, Limited, London	4,700
Scott & Mountain, Newcastle-on-Tyne	4,865
Laing, Wharton & Down, London	4,998
Matthews & Yates, Manchester	5,385
Heath, Snoxell & Co., Birmingham	5,540
Crompton & Co., London	5,650
Thomas & Taylor, London	5,700
Prestwich & Butt, Kingston-on-Thames	5,804
Sax, Slatter & Co., London	9,500
Summerscales & Sons, Keighley (laundry only)	557

NOTE.—There were two lower tenders.

Middlesbrough.—The Town Council at their last meeting had under consideration the reports of the Electric Lighting Committee, and the consulting engineer, Mr. Robert Hammond, on the tenders submitted for the plant and mains required for the Municipal Electricity Works, when the following were accepted:—

Sec.	Plant.	Name of firm.	Amount.
A.	BOILER HOUSE PLANT: 3 Lancashire boilers; 3 sets mechanical stokers; steam feed pump; electric feed pump; injector; electric motor and switch gear; weighing machine, barrows, &c.	Houldsworth & Sons, Bradford.	£3,058 5 0
B.	ENGINE HOUSE PLANT: One 300-kw. slow-speed steam dynamo; one 100-kw. high speed ditto; 200 sq. feet floor plates; motor transformer; tools and instruments; oil filtering apparatus; painting and spare parts.	Davy Brothers, Ltd., Sheffield (with P. R. Jackson & Co.'s dynamos).	£6,900 0 0
D.	Overhead travelling 15-ton crane, handrailing, ladder, and 100 feet of steel rail.	Southgate Engineering Co., Ltd., New Southgate.	£325 0 0
E.	Switchboard and instruments ..	Nalder Bros. and Thompson, London.	£1,200 0 0
F.	Accumulators, stands, and instruments.	Hart Secondary Battery Syndicate, Stratford, E.	£1,880 16 0
G.	UNDERGROUND WORK: Trenching; brick surface boxes; troughing; cables; joint boxes, &c.	The British Insulated Wire Co., Ltd., Prescot.	£8,711 1 1
H.	METERS: 100 direct current meters.	Chamberlain & Hookham, Birmingham.	£500 0 0

Sheffield.—The Tramways Committee of the Corporation have, according to an exchange, recommended the following tenders for acceptance:—Cole, Marchant & Morley, Bradford, for two engines for the extensions at Kelham power station, £6,796, on condition that such engines are strictly in accordance with the specifications of the electrical engineer; J. Brown & Co., for supply of four boilers (similar to those previously supplied) for the extensions at the Kelham power station, £6,250; British Thomson-Houston Company, Limited, for two tramway generators of 500 kw. capacity, £5,280 12s 6d.; that an extended contract be entered into with J. Eshelby for the construction and erection of extensions to the power station at Kelham Island, on same schedule of prices as contained in his present contract, the city surveyor estimating the cost at from £9,000 to £10,000.

FORTHCOMING EVENTS.

Friday, February 10th.—At 5 p.m. Physical Society. Annual General Meeting: address by the president. After which at an ordinary meeting, "An Amperemeter and a Voltmeter with a Long Scale," by Benjamin Davies; probably to be read by Dr. Lodge.

At 8 p.m.—Institution of Civil Engineers, Students' Meeting, paper on "The Electrical Driving of Engineering Workshops," by William Middleton, Stud.I.C.E.

At 7.30 p.m.—At the Westminster Palace Hotel. The Institution of Junior Engineers, joint meeting with the Discussion Section of the Architectural Association. Paper on "Factory Design," by Mr. J. H. Pearson, M.I.J.E.

Saturday, February 11th.—At 2.30 p.m. Visit of Institution of Electrical Engineers (Students') to the Shoreditch Central Station, Coronet Street, Shoreditch. Party limited to 20.

Saturday, February 18th.—At 3.15 p.m. Institution of Junior Engineers visit to the Ealing Electric Lighting and Destructor Works.

NOTES.

Nernst's Electric Glow Lamp.—As we go to press, "Optimist, London," writes as follows:—"In the descriptions of the above which have appeared in the technical journals, and been published in the Patent Specifications, and also in the explanation and exhibition of the lamp given by Mr. Swinburne at the Society of Arts on Wednesday, 8th inst., great stress has been laid on the fact that the filament does not require to be sealed in a vacuum; Mr. Swinburne, indeed, went so far as to say that it would not work in a vacuum. Some of the speakers on Wednesday seemed to think that in a few months all our present glow lamps would be replaced by the new open filament lamps, and predicted bad days for the poor incandescent lamp manufacturers. It appears to me, however, that a most important fact has been entirely overlooked, no mention, whatever, being made of it on Wednesday last, either by Mr. Swinburne, or by those who spoke in the discussion, namely, that the great strides made in electric lighting by glow lamps, are almost entirely due to the filament being enclosed in an hermetically sealed globe, thus rendering it quite safe, and allowing it to be used in many places where gas in any form would be quite out of the question, and so, of course, the exposed filament type of electric glow lamp. No doubt, for outdoor lighting, the Nernst lamp will be of great value; but a reference to the tables of electric light undertakings will show that outdoor lighting is a very small item in most central station accounts, so that the usual enclosed filament glow lamp would appear to still have the largest field, *i.e.*, indoor lighting. No doubt the Nernst filament can be partially enclosed, and used indoors, too, but the advantages of a glow lamp with a filament hermetically sealed in a globe are so obvious, especially from the point of view of fire risks, that there is still hope for the oft-abused lamp maker, who produces glow lamps that will light without the aid of a match or a spirit lamp."

The Cowper-Coles Electrolytic Processes.—As we go to press the following letter comes to hand from Mr. Charles J. Beaver:—"The correspondence on this subject appears to have culminated in the question of priority in the matter of the use of revolving disc cathodes. Will you allow me, as one who was for several years intimately acquainted with all phases of Mr. Cowper-Coles's electrolytic work, to state that revolving disc cathodes, as well as revolving cathodes of other forms, were used by him long before the date of Dr. Tommasi's patent. The advantageous effects of their use were well known to him and his laboratory staff."

Lectures.—On Monday afternoon Mr. R. W. Hancock lectured on "Everyday Applications of Electricity" at the London Institution, Finsbury Circus.

At the Barnfield Hall, Exeter, on 2nd inst., Mr. H. G. Massingham delivered a lecture to the members of the Exeter Literary Society upon "Electricity as a Lighting, Heating, and Motive Power."

Under the auspices of the Bradford Sunday Society on Sunday last, Mr. A. Thornton lectured on "Wireless Telegraphy."

Before the Mason University College Engineering Society at Birmingham last week, Mr. H. Lea read a paper on "Some Practical Points in Electric Lighting."

At a meeting of the Birmingham Association of Mechanical Engineers on Saturday, Mr. G. Conaty, of the Birmingham and Midland Tramways Company, read a paper on "Electric Traction; its application in large towns."

On 1st inst. Mr. W. H Whitehouse, A.I.E.E., lectured on "Electrical Work in Connection with Buildings" before the Birmingham Clerk of Works and Builders' and Foremens' Association.

Appointments Vacant.—The Leyton District Council want an electrical engineer to take charge of the electricity undertaking at £250 per annum, rising to £400. See our "Official Notices."

The Halifax Corporation want an assistant electrical engineer. The Southport Council also want an electrician-in-charge. See our "Official Notices."

Fire Prevention.—There has just been incorporated a new society of about 500 members, known as the British Fire Prevention Committee. Mr. Edwin O. Sachs is the founder and the chairman of the executive. The Committee includes officials of all trades or professions who may be either directly or indirectly interested in the prevention of fire, such as surveyors, engineers, municipal officers, architects, &c. The Committee proposes (1) to direct attention to the urgent need that exists for increased protection of life and property from fire by the adoption of "preventive" measures; (2) to use its influence in every direction towards minimising the possibilities and dangers of fire; (3) to undertake such independent investigations and tests of materials, methods, and appliances as may be considered advisable. A testing station is being constructed by the Regent's Canal where such investigations will be carried out. Three test huts have been already put up. The temperature inside these huts can be continuously recorded. This is done by thermo-junctions and reflecting galvanometers of the same type as Sir Roberts-Austen uses at the Mint.

Flash Advertisements.—The irritation and inconvenience caused by the use of flashlight advertisements in crowded thoroughfares in the metropolis has resulted in the presentation of a memorial to the London County Council by numerous architects. They protest against the method of advertising by means of large letters or other emblems illuminated by the electric light or gas. The memorialists suggest the expediency of applying to Parliament for such powers as may enable the Council to deal effectually with this and cognate abuses. The search light advertisements have caused trouble among the street traffic on numerous occasions, and this consideration is more likely to move the London County Council and the general public than the architectural abuse argument.

The Franklin Institute.—In attaining the age of 75, the Franklin Institute is considered to have taken a place as an old Institution in the United States. Dating as it does, says *Cassier's Magazine*, from the early years of the century, it has seen all that has been accomplished in mechanical science since the locomotive became a public machine. It was started with the object of promoting and encouraging manufacturers, and the mechanical and useful arts. It has thus some resemblance to the Society of Arts, but has perhaps a rather more practical side, while at the same time being on a higher plane than the Mechanics Institute. It is a self-supporting Institute, boasts of a library of 50,000 volumes, and over 36,000 pamphlets, maps and charts, now housed in metallic stacks in a fireproof part of the Institution Building, which stands in South Seventh Street, Philadelphia. The regular meetings of the Institute afford, and have afforded, a convenient medium for the communication of many discoveries in chemistry or physics or novel applications of the sciences generally. In the museum attached to the Institute is Franklin's electrical machine and models of historical machines, as well as some perpetual motion machines, while the *Journal of the Franklin Institute* is world known. It was to the Institute that the U.S. standard of screw threads was due, and from time to time practical science has been furthered by its influences and aids.

Lord Kelvin.—The Institution of Electrical Engineers has elected Lord Kelvin an honorary member of the Institution. His Lordship is the first to be elected under the new rules.

Everard v. Higgs.—In this action, heard on October 26th last, plaintiff recovered £50 in respect of a claim for shares in the I.E.S. Co. Yesterday defendant's appeal was heard and dismissed by their Lordships.

Personal.—Mr. E. H. Mottram, who has been an official of the Birmingham Tramways Company for nearly 13 years, has been appointed superintendent of the Oldham, Ashton-under-Lyne, and Hyde Electric Tramways.

The Queensland Government Electrical Engineer.—An Australian paper says that a deputation representing the consulting engineers in the city of Brisbane waited on the Postmaster-General in December to protest against the Government electrical engineer doing private work. Mr. Wilson replied that when that officer was engaged it was with the stipulation that he be allowed the right of private work. His agreement terminated in 1899, and if any fresh agreement were made the views of the deputation would be considered.

The Röntgen Society.—At a meeting of the Röntgen Society last month, Major Battersby read a paper on "The Röntgen Rays in Military Surgery," in which he gave an account of the use made of the Röntgen rays in the Sudan campaign. After the battle of Omdurman, 121 British wounded were conveyed to the military hospital at Abadieh. Of that number there were 21 cases in which the bullet could not be found, or its absence proved, by ordinary methods. In 20 out of these 21 cases an accurate diagnosis was arrived at with the help of the rays, the odd case being too ill for examination. The greatest difficulty Major Battersby experienced was in obtaining current to work his coil. Finally, the difficulty was successfully overcome by driving a dynamo with a tandem bicycle. The current for the dynamo was used either for charging accumulators or for supplying the coil direct. The only objection to this apparatus was the difficulty of transport. Major Battersby thinks some form of the influence machine would be the ideal generator. In this we think he is mistaken. The influence machine is extremely susceptible to climate. In the Sudan it might work, as the climate is, as a rule, very dry; but in Cuba the American military surgeons found it was a complete failure. A machine large enough for practical work would also be very cumbrous and very fragile. The bicycle-dynamo installation in some improved form will probably, after all, prove the best.

The Mechanicals' New Home.—The new buildings of the Institution of Mechanical Engineers which have been erected at Storey's Gate, St. James's Park, at a cost of about £35,000, although not quite completed, are being used by the secretarial staff. The formal opening may not take place for some time, but the Institution held a meeting there yesterday (Thursday) afternoon. The premises are stated to be equipped in a very complete manner, all the lighting and power used throughout being electrical.

Electricity and Plants.—At a lecture given on 3rd inst. to the Amateur Horticulturist Society, Dr. E. H. Cook, F.I.C., F.C.S., of the Clifton Laboratory, Bristol, described some successful experiments which he had made in forcing plants by electricity, and said that in order to multiply experiments and extend knowledge of the subject, he was prepared to submit to the action of electricity the seeds of any plants which might be sent to him, and he would send a report stating the results of the experiment.

Electric Power at Kalgoorlie.—A despatch from Perth (W.A.) to the *Financial News* says that the managers of some of the leading mines on the Kalgoorlie field are urging their companies to combine in erecting a central electric power station for supplying electric power to the various mines for stamping, hoisting, winding, and pumping purposes, thus following the action taken for the first time in Australia by the English companies engaged in working the deep leads in Victoria.

Mr. Quin's Position at Blackpool.—The Electric Light Committee recommended the Council on Tuesday to allow Mr. Quin, the borough electrical engineer, to accept private consulting work, his salary to be fixed at £400 for three years. The Council discussed the matter briefly, and referred the matter to the General Purposes Committee. It was thought that if permission were given to Mr. Quin, other officials would want to do the same.

Royal Institution.—At Monday's meeting several new members were elected, and a resolution was passed expressing sympathy with the relatives of the late Duke of Northumberland, who had rendered invaluable services to the Institution for 48 years.

The Northern Society of Electrical Engineers.—The annual meeting of this society will be held at the Grand Hotel, Manchester, on Tuesday, February 28th, at 7.30 p.m. o'clock. The business will include the following:—(1) To receive report of Council; (2) To elect a president for the ensuing year; (3) To elect the Council and officers for the ensuing year; (4) To receive the president's address.

Wireless Telegraphy.—Further trials of the Marconi system were made on 30th ult. at the South Foreland lighthouse, in the presence of representative from the Councils of Dover, Ramsgate, Margate, Broadstairs, Sandgate, &c. The trials were under the supervision of Signor Marconi. The system acted well. The height of the pole used for transmission was 130 feet, and Signor Marconi considered that by this a message could be sent to the French coast. The receiving wire on the lightship was run 80 feet up the mast. Promises of support to a resolution urging the Board of Trade and the Admiralty to take up the system were given.

It is announced that experiments are about to be taken in hand with Marconi's system of telegraphy without wires between Messina and Reggio.

The Copper Market.—Messrs. H. R. Merton & Co.'s last fortnightly circular contains some startling figures. The price of G.M.Bs. has advanced from £60 10s. to £69 10s. during the fortnight ending January 31st, a rise, we suppose, unprecedented in the history of the metal. The following series of prices on January 31st in successive years are interesting:—1896, £43 17s. 6d; 1897, £51 2s. 6d.; 1898, £49; 1899, £69 10s. The European stocks of copper, in port and afloat, are 26,015 tons, a decrease of 565 tons during the fortnight, and of 1,880 tons during the month. The total supplies in January were 18,904 tons, as against 20,785 tons delivered. This decrease in stock does not justify the enormous rise in price which has occurred, and the market is evidently being exploited in the interests of sellers. The movement will, however, defeat itself, for with copper at £69 10s. per ton, it will pay electrical engineers under certain conditions to make use of aluminium in place of copper for conducting purposes. Using the formula and data given by Mr. Kershaw in our issue of September 16th, 1898, and substituting 7·31d. for 5·94d. as the price of copper per pound, we obtain the ratio $\frac{100}{110}$ as the relative costs of conductors of copper and aluminium of equal sectional resistance. If, however, the price of aluminium be taken at 14·5d. per pound (the Pittsburg Reduction Company are offering the metal in rod or bar form for conducting purposes at this price), the ratio becomes $\frac{100}{100}$, and copper at the present market price no longer possesses any economic advantage for electrical conducting purposes as compared with aluminium. It will be understood that we are not referring to insulated conductors.

NEW COMPANIES REGISTERED.

British Mutoscope and Biograph Company, Limited (60,403).—This company was registered on January 23rd, with a capital of £300,000 in £1 shares, to acquire the business and certain patent rights and other parts of the property of the Mutoscope and Biograph Syndicate, Limited, and in particular the machines or instruments known respectively as "Mutoscopes," "Biographs," and "Mutographs;" to enter into an agreement with the said syndicate; to manufacture, sell, purchase, let out on hire, erect, maintain and exhibit such instruments, and to carry on the business of electricians, electrical, mechanical, chemical and metallurgical engineers, suppliers of electricity, photographers, &c. The first subscribers (each with one share) are:—E. B. Koopman, 18, Great Windmill Street, W., managing director; W. T. Smedley, Newhall Street, Birmingham, chartered accountant; F. T. Macdonald, 2, New Court, Lincoln's Inn, barrister; C. A. Pearson, Frensham Place, Farnham, newspaper proprietor; E. Hudson, 71, Lancaster Gate, W., printer; G. Newnes, Bart., Putney Heath, S.W., and S. J. Field, 18, Great Windmill Street, W., secretary. The first directors (to number not less than two nor more than seven) are to be nominated by the subscribers; qualification, £500; remuneration, £1,500 per annum, and a share in the profits, divided between them. Registered office, 18 and 19, Great Windmill Street, Shaftesbury Avenue, W.

Trafford Power and Light Supply, Limited (60,419).—This company was registered on January 24th, with a capital of £100,000 in £1 shares, to enter into an agreement with William P. J.

Fawcus for the acquisition of a concession for the sole and exclusive right and privilege to supply electricity and fuel gas for lighting, heating, traction, motive power, or other purposes, to the whole of the roads, streets, and premises in Trafford Park Estate, Manchester, and to carry on the business of electricians, electrical engineers, suppliers of electricity and gas, iron founders, tool manufacturers, boiler makers, machinists, &c. The first subscribers (each with one share) are:—W. P. James Fawcus, Red House, Altrincham, engineer; Joseph Nasmith, 61, Barton Arcade, Manchester, engineer; Godfrey B. Samuelson, 7, Cadogan Gardens, S.W., manufacturer; Henry Edmunds, 2, Queen Anne's Gate, S.W., manufacturer; Frederick Smith, Caledonia Works, Halifax, wire manufacturer; James E. Baxter, Leyland, Lancs, rubber manufacturer; and George W. Lowcock, 78, King Street, Manchester, engineer. The number of directors is not to be less than two nor more than seven; the first are to be nominated by the subscribers; qualification, £250; remuneration, £750 per annum and a percentage of the profits divided between them. Registered office, 78, King Street, Manchester.

Electric Canal Haulage Company, Limited (60,462).—This company was registered on January 27th, with a capital of £3,000 in £1 shares, to adopt an agreement with B. H. Thwaite and George Cawley, and to establish electric generating stations for the distribution and use of electric energy for the purpose of hauling vessels. The first subscribers (each with one share) are:—George Cawley, consulting engineer; Chas. A. Embleton, engineer; John Cawley, clerk; Benjamin H. Thwaite, consulting engineer; Horace Allen, civil engineer; and Thomas J. Denney, mining surveyor, all of 29, Great George Street, S.W.; Miss Ada M. Cawley, 54, Huron Road, Balham, S.W. Registered without articles of association.

Medical Electro-Thermic Generator Company, Limited (60,475).—This company was registered on January 28th, with a capital of £20,000 in £1 shares, to acquire, take over as a going concern, and carry on the business of proprietors of hot baths carried on by the Medical Electro-Thermic Generator Company, Limited, at 31 and 32, Upper Berkeley Street, W.; Buxton Hydro., Buxton; Royal Baths, Harrogate; Clifton Grand Spa, and elsewhere, and to acquire, sell, and use the Greville Electro-Thermic Air Baths. The first subscribers (each with one share) are:—G. Hickson, 15, Wickham Terrace, Towcester, clerk; A. E. Greville, Towcester, solicitor; T. W. Precious, 1, Norland Gardens, Norland Road, clerk; H. J. Garlick, 54, Porchester Road, Bayswater, clerk; H. E. Greville, 32, Upper Berkeley Street, W., solicitor; Reginald H. Andrew, 2, Nutford Place, W., electrician; and J. Dickinson, 39, Bayham Street, Camden Town, bath attendant. Registered without articles of association. Registered office, 2, Staple Inn, Holborn, W.C.

Yale Electric Power Company, Limited (60,493).—This company was registered on January 31st, with a capital of £10,000 in £25 shares, to adopt an agreement with Thomas P. O. Yale, and to carry on the business of an Electric Light and Power Company at Blaenau-Ffestiniog, in Merioneth, North Wales. The first subscribers (each with one share) are:—Frederick S. Percival, Bodawen, Portmadoc, North Wales, quarry proprietor; Horace Percival, New House, Pakenham, Suffolk, major-general; Francis W. Percival, 2, Southwick Place, W., barrister; Cecil E. Green, Oakfield, Forest Row, Sussex, gentleman; Thomas P. O. Yale, Red House, Rhos, Mon., electrical engineer; William C. Yale, J.P., D.L., Plas-yn-Yale, Corwen, North Wales; Edward H. Percival, J.P., Kenisbury House, Gloucester. The number of directors is not to be less than three nor more than five; the first are the first five subscribers; qualification, £200; remuneration, £100 per annum divisible.

"Steady" Arc Lamp Company, Limited (60,532).—This company was registered on February 3rd, with a capital of £20,000 in £1 shares, to carry on the business of electric lamp manufacturers, mechanical, electrical, and gas engineers, millwrights, timber merchants, and suppliers of electricity. The first subscribers (each with one share) are:—Walter B. Clowes, 55, Donnington Street, Leicester, secretary; James S. Blackwell, 54, Clarendon Street, Leicester, electrical engineer; William A. Charles, 12, Kennington Mansions, S.E., engineer; Frederick C. Geary, 51, Kirby Road, Leicester, electrical engineer; Edwin E. Voss, 57, Bull's Head Street, Leicester, electrician; Douglas Francis, Mansfield Street, Leicester, range merchant; Alfred Lock, 18, Frog Island, Leicester, electrician. The number of directors is not to be less than three nor more seven. The first are Wm. A. Charles, James S. Blackwell (managing directors with £250 each per annum), Laban Simpson, Arthur J. Davis, John F. Neal, John Rollitson, and Andre Stahl; qualification, £100; remuneration as the company may fix.

Search Light Syndicate (of America) Limited (60,537).—This company was registered on February 3rd, with a capital of £30,000 in £1 shares (9,000 "A," 10,000 "B," and 11,000 "C") to adopt an agreement with Thomas W. Goad and James N. Sparks, and to carry on the business of reflector and projector manufacturers, importers and exporters, builders, engineers, electricians, metal workers, &c. The first subscribers (each with one share) are:—Thomas W. Goad, E.M.C.E., Westgate-on-Sea; J. N. Sparks, A.M.I.C.E., Winchester House, E.C.; J. B. Moffatt, Winchester House, E.C., clerk; B. M. Woodhouse, 52, Cannon Street, E.C., chartered accountant; J. Arnold Norton, Billiter Buildings, E.C., secretary; Henry J. Welch, 82, Abbeville Road, Clapham, S.W., clerk; Thomas M. C. Steuart, 16, Albany, Road, Camberwell, S.E, clerk. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first; qualification, £100; remuneration, £500 per annum and 5 per cent. of the net profits divisible. Registered office, 22, Billiter Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Binko, Ridsdale & Co, Limited (54,566).—This company's statutory return was filed on November 11th, when the whole capital of £24,000 in £1 shares was taken up, and paid for in full.

Bright's Light and Power, Limited (58,290).—This company's statutory return was filed on December 8th, when 66,667 shares were taken up out of a capital of £200,000 in £1 shares; 5s. per share has been called on 66,660, and £1 per share on the others; £16,547 has been paid, and £125 is in arrears.

Berry's Electrical Company, Limited (58,587).—This company's statutory return was filed on December 31st, when 888 shares were taken up out of a capital of £3,000 in £1 shares, and paid for in full.

Central Electric Supply Company, Limited (53,080).—This company's annual return was filed on January 19th, when 307 shares were taken up out of a capital of £100,000 in £5 shares; £1 per share has been called on 300, and no calls have been made on the others; £300 has been paid.

Chelmsford Electric Lighting Company, Limited (36,124).—This company's annual return was filed on January 18th, when 9,878 shares were taken up out of a capital of £50,000 in £1 shares. £9,871 has been paid, and £7 is in arrears.

Bromley (Kent) Electric Light and Power Company, Limited (54,127).—This company's annual return was filed on January 4th when 1,637 shares were taken up out of a capital of £20,000 in £5 shares. £1 per share has been called and £1,637 received.

CITY NOTES.

The St. James's and Pall Mall Electric Lighting Company.

Some very important matters were discussed at the meeting of this company, held on Tuesday last, but, as far as the shareholders were concerned, no question exceeded in interest that relating to the issue of new shares at a premium. The suggestion of the directors was, that such a premium would provide a substantial addition to the reserve, but this was resented by a strong body of shareholders, and these differences of opinion led to the whole of the shareholders being circularised both on behalf of the board and their opponents. No one denies the wisdom of building up a large reserve, and, as far as possible, it ought to be furnished from revenue; but when it becomes necessary to raise fresh capital, we think that a company whose shares stand at three times their nominal value is justified in issuing shares even to the proprietors at a premium. It might have been a pleasant thing for individual shareholders in the St. James's Company to have bought large batches of shares at par value and sold them next day at something like the present market price; such a proceeding would enrich the individual, but would not help the joint purse of the company. Therefore, as it is the duty of the board to consider the interests of the whole body of shareholders, they were well advised in suggesting the issue at a premium, and the proprietors showed their good sense by accepting the recommendation of the directors. We must, however, raise a protest against an alarmist paragraph in the circular issued to the shareholders by the board. It is, we admit, important to impress the shareholders of the grave necessity of providing a reserve fund, but to do that by stating that the electric supply business is an industry "depending entirely on elaborate and refined machinery," is, we fear, slightly exaggerative and quite undesirable.

Westminster Electric Supply Corporation, Limited.

The report of the directors, to be presented to the ordinary meeting of shareholders to be held on Wednesday, February 15th, at Eccleston Place, states that the supply of current which, on December 31st, 1897, was provided for the equivalent of 290,561 lamps of 8 C.P., had increased by December 31st, 1898, to the equivalent of 339,986, and at the present time there are on circuit the equivalent of 343,617, and applications have been received for a further 8,134 lamps of 8 C.P. The length of roadway in which mains have been laid now exceeds 48 miles, making about 197 miles of ways, into which upwards of 168 miles of copper (strip and cable) have been drawn. The directors have taken special steps to encourage the use throughout the system of supply of 200-volt lamps. The effect of this change, when completed, will be to increase very greatly the capacity of the existing mains and to reduce future capital expenditure under this

head. The extensions of the central stations at Davies Street and Eccleston Place, referred to at the last general meeting, have been completed, and the plant is at work. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue. Owing to the continued increase in the applications for current, the central station at Davies Street is now practically equipped for its maximum supply, while the space available at the other stations will shortly be utilised. As it has been found impossible to obtain a further suitable site for extension or the provision of a new station within the corporation's authorised area, the directors have united with the board of the St. James's and Pall Mall Company in promoting a Bill for a joint central station outside the companies' areas, for the purpose of supplying current in bulk to the existing stations of this corporation and of the St. James's company. The capital invested in this undertaking, as shown in the balance-sheet, is at present unremunerative. The late prolonged strike in the South Wales coalfields, and unforeseen difficulties in the completion of Millbank Street station, have caused very considerable additional expense during the year. The directors consider that they may congratulate the shareholders on the fact that, notwithstanding these difficulties and the extra rebate allowed to consumers, which came into force on January 1st, 1898, the total cost per unit remains about the same, and there is no decrease in the amount available for dividend. An interim dividend, at the rate of 10 per cent. per annum, for the half-year ending June 30th, 1898, has been distributed. After allowing for depreciation, sinking fund, &c, the net balance available for dividend is £28,033 6s. 4d.; the board therefore recommend the payment of a dividend at the rate of 14 per cent. per annum, less income-tax, for the past half-year, making 12 per cent. for the year ending December 31st last, carrying forward a balance of £1,000 9s. 8d. The directors have to record with extreme regret the death during the past year of their colleague, Mr. James Heslop Powell, and in accordance with Article 127 of the articles of association, they have elected the Right Hon. Lord Ampthill to fill the vacancy. In accordance with the articles of association, two of the directors, W. Hayes Fisher, Esq., M.P., and Sir Douglas Galton, K.C.B., retire; but, being eligible, offer themselves for re-election.

Anglo-American Telegraph Company.

The ordinary general meeting of the Anglo-American Telegraph Company, Limited, was held on Friday last at Winchester House, Old Broad Street. Mr. Francis A. Bevan presiding.

The Chairman, comparing the figures of the past half-year with those of the corresponding half-year, said there had been an increase in receipts of no less than £14,418, the total receipts being £190,520, as against £176,102. In addition to these increased traffic receipts they had also earned during the past half-year £3,800 by the letting out of the *Minia*, and besides that they brought forward a balance of £17,580. They had, therefore, the gross amount to deal with of £212 493, as against £187,832 last year. The increase over the corresponding half-year in working expenses was £2,329, and in repairs of cables £2,668; altogether £5,032. Deducting that from the £15,558 gross increase on the receipts, they had an increase of £10,555, as compared with the corresponding period of last year. The renewal fund had increased during the year by £59,700—derived, £24,000 from the amount agreed to be taken out of revenue, £21,000 from interest, and they had realised some of their securities, on which there was a very handsome profit of £14,300. These three items made up a sum of £59,700. The renewal fund was gradually attaining a very substantial amount, but it was the right policy to pursue, at all events for the present, to go on increasing that renewal fund. The result of these increased receipts was that they were able to give the deferred shareholders a dividend. They were able, after paying the preferred shareholders their 6 per cent., to give the ordinary shareholders £3 9s. for the year, and 18s. to the deferred shareholders. Of the amount required for this, no less a sum than £17,558 had been derived from the earnings of the *Minia* during the past year, and had they not had that windfall they would not have been able to give the deferred shareholders this substantial dividend. They had begun the year very well, and the gross receipts of the pool, of which the Anglo was entitled to 55 per cent., were rather more than £5,000 for the first month of the year above what they were in January, 1898. The 1874 cable had been broken, but not at any great distance from the land, and at a place where there was no difficulty in repairing it. When the ice which was now down in the Bay had cleared away, they would be able, without the slightest difficulty, to mend the 1874 cable. He need scarcely say that they endeavoured in every way to keep up to date as to appliances, to perfect as far as possible the work they did, and he believed they would continue to diminish what was called technically "delay in the messages"—namely, the time occupied in the transmission of messages between this country and America. No effort would be spared on the part of the directors or the management in order to ensure that this traffic should be conducted as perfectly as possible. The arrangement which had been in operation for many years, by which this company carried the German traffic, expired at the end of the year, and the German Post Office had given them notice that from the end of the year they would no longer be asked to carry their messages. This meant that they were going to make arrangements to lay a cable for themselves. The directors of the Anglo-American Company had had a great deal of negotiation with the German Post Office authorities, and had tried in every way to make some arrangement with them by which the laying of this cable should be avoided. All efforts had hitherto been unavailing, and the Germans seemed to think that they ought to have a cable of their own. If they had made up their minds to that it was impossible to prevent their carrying those wishes into operation, but he was not aware either that the capital necessary for laying the cable had been subscribed or that any cable had been ordered. If this cable was laid it certainly would not be for the requirements of the traffic. It was absolutely unneeded as far as traffic was concerned; the existing cables were quite able to carry all the existing traffic, and could carry a great deal more. The chairman of the Direct United States Company rather seemed to convey the impression to his shareholders that their cables were pretty full, but he (the speaker) was inclined to take the other view, and to say that they could still carry a great deal more traffic than at present, and that, therefore, this cable, if laid, was perfectly unnecessary as far as traffic purposes were concerned. He did not exactly understand how those German gentlemen who laid the cable were going to make very much profit out of it, but that was their concern. They had before them the example of the French company, which had made nothing since it left the pool in 1886: and if the Germans were to make any profit it must be that they had a substantial guarantee from the Government. Again, though they might carry the traffic one way—outward from Germany—he did not see how they were going to get traffic from the other side. The whole of the traffic there was in the hands of the allies of the existing companies, who were bound to hand to them all the traffic that they could collect; and if the new German cable were to make arrangements with any or the existing companies, it was evident the existing companies must give up some portion of theirs. He did not think they need be too much alarmed as to this threatened German cable. Probably it would come off in some way or another, but he did not think the loss would be to them quite so much as some people thought. It would be a loss undoubtedly if carried out. There was no concealing that fact; but, considering that the company's ordinary traffic was increasing, he was not fearful that this threatened competition would affect them so very severely. The German Government might find some way in which they could carry out their arrangements. Meanwhile, all this company could do was to sit still. The chairman concluded by moving the adoption of the report and approval of the dividends as recommended by the directors, which was accepted.

St. James's and Pall Mall Electric Light Company.

The ordinary general meeting of the shareholders of the above company was held on Tuesday at the offices, Carnaby Street Central Station, Golden Square, W., Mr. Eustace J. A. Balfour, the chairman, presiding.

The report and accounts having been taken as read, the Chairman, in moving their adoption, said that since he had the pleasure of meeting the shareholders last year the business of the company had been carried on in a satisfactory manner, and he was in a position to congratulate them on the continued success of the undertaking. The extensions at Carnaby Street central station had been completed and equipped with machinery of the most modern type, and the station was now in full working order, with a plant of 4,500 horse-power. The Mason's Yard station had been fitted with new engines to overcome the difficulties which were experienced from vibration, and that station had been running satisfactorily throughout the year, in conjunction with the Carnaby Street station, with its full plant of 1,500 horse-power, and there had been no cause of complaint. In the course of the year they had added a total of 12,026 lamps to their service, amounting to an increase of upwards of 13 per cent., and they had now a total of 142,853 connected. Fresh orders were coming in daily, including several large consumers, and there was every reason to suppose that the business would continue to expand in the same steady manner as it had in the preceding years. A further reduction had been effected in the working expenses, and it was notable that in spite of the unfortunate strike which took place in the Welsh coal trade, and which enhanced the price of coal, their cost per unit of electricity—which was the lowest of all the metropolitan companies—had been slightly reduced, and he might also add that he believed they were among the very few companies against which no complaint was made in the matter of smoke. As he informed them in his speech last year the directors had acquired a freehold site on which they proposed to deal with all future extensions and so secure economy in working. They had resolved to enter into an agreement with the Westminster Electric Supply Corporation to promote a Bill in the ensuing session of Parliament under the title of the Central Electric Supply Company, Limited, to erect a joint station for the supply of electricity in bulk to their respective districts, and to share the expenses. Unfortunately, that Bill was opposed in the last session of Parliament by the Great Central Railway Company, who succeeded in getting compulsory powers over the land for their own purpose, thus delaying them a full year in their operations—time which they could ill spare. A fresh Bill had been drafted for the ensuing session, and a suitable plot of land had been scheduled for compulsory purchase, and in view of the favourable attitude of the Joint Committee of Parliament which had under consideration last year the granting of additional facilities to electric supply undertakings, he thought there was a reasonable prospect that the scheme would be carried through to a successful issue. The Central Electric Supply Company, which would be controlled by the joint boards of the St. James's and the Westminster Companies, and placed under the same management, would be able to supply all the future requirements of both companies in the most economical manner. The result of the Bill would be to enable the directors to take steps to meet the growth of their business. The present plant would suffice for their requirements for another season only, and it was imperative that provision should be made for further extensions for the winter

of 1900. The directors therefore were proceeding by Bill in the ensuing session of Parliament to acquire, by compulsory purchase, certain property at the back of Carnaby Street station, and they proposed to extend their present premises, and put down sufficient plant as would enable them to meet all requirements. Out of the profits of the year's working, the board proposed a dividend of 12½ per cent., with a further bonus of 2 per cent.; but as he had pointed out last year, the dividend of 14½ per cent. was, in a certain way, a fictitious one. With regard to the founders' shares, as they were aware, those rights had been extinguished by purchase—by the issue to the founders' shareholders of 12,000 ordinary shares. At present the founders' shares were held by him (the chairman) in trust for the company, and would shortly be technically as well as practically extinguished. The ordinary capital of the company would then stand at £160,000, and the directors proposed to round off the ordinary share capital by the issue of the remaining 8,020 shares. They had deemed it advisable to pay off £50,000 4 per cent. debenture stock, so that at the commencement of next year the capital would stand at £200,000 ordinary and £100,000 preference share capital, and the company would then have clean borrowing powers to the extent of half its capital issue to deal with its extensions. The premium on the issue of these 8,020 ordinary shares would be placed as on a previous occasion to reserve. That would considerably strengthen the position of the company, and enable them to place the capital to the best advantage. These shares, in accordance with the articles of association, would be issued *pro rata* to the shareholders, and although he was not in a position to say at what price the issue would be made, he might state that it was the intention of the directors to act on the policy of building up an adequate reserve fund, and also of giving adequate profits to the shareholders. He was sorry to say that on that question the directors were in disagreement with certain large shareholders, and the board had thought it right to issue a circular to the shareholders, in which they laid their views on the matter very fully before them, and in which they asked them to support their policy. In reply to that two circulars had been issued, in which, while no objection was taken to the formation of proper reserves, the opinion was expressed that such reserves should be provided out of revenue. In looking at that question, the first thing to be said was that the directors were not prepared to depart from their settled policy of many years past—a policy which had been approved by the bulk of the shareholders. It must be remembered that the company was going to Parliament for extended powers this year, and he felt sure that if they adopted the suggestion of some shareholders, and issued those shares at par, they would not stand any chance of getting their Bill through. They were, too, undoubtedly on the eve of seeing inventions introduced into electric lighting which would very much reduce its cost. It was very difficult to prophesy what exact effect that would have upon the company, but it might be that it would produce an increased demand, so great and so sudden that they would have the utmost difficulty in meeting it. In that case, the question of raising fresh capital very rapidly might arise, and with the reserve fund which the issuing of the 8,000 odd shares would give them they would be able to meet such circumstances by raising new capital at a comparatively low rate of interest. Therefore, in view of all the circumstances of the case, and especially in view of their applying to Parliament for compulsory powers he and his fellow directors believed their policy to be a wise and a politic one. They must never forget that they were a public, and not a private company. They had no monopoly. Competition had been keenly felt in the past, and would probably be again felt in the future, and in the face of competition a strong financial position was the only safeguard. In conclusion, he said that although the board were always sorry to differ from any section of their shareholders, yet they felt bound in this case to adhere to their settled policy, in which, he was glad to say, they were supported by a majority of the shareholders, as evidenced by the proxies they had received.

Sir J. H. Morris seconded the resolution.

Mr. E. P. S. Reed wished to move an amendment to the effect that it was desirable that the 8,020 shares should be offered to the shareholders at par and not at a premium.

The Chairman said he could not accept that as an amendment, upon which Mr. Reed said he would be compelled to move that the report of the directors be not adopted. With reference to the point at issue, he said he thought the matter affected the shareholders perhaps more than it did the directors. They might assume that a substantial premium would be asked—say, from £6 to £8 per share—and they, the present shareholders, would be asked to put their hands in their pockets to that extent for the purpose of establishing a capital reserve fund. If the shares were to be offered to the public it might be wise and judicious to issue them at a premium, but he did not think such a policy was right to adopt in the present case. It was asking the shareholders to put their hands in their pockets and subscribe a heavy premium for the benefit of posterity.

Mr. D. Hutton seconded the amendment, and said he felt very strongly that the shareholders ought to receive those shares at par. According to the directors they were to pay a large premium to create a fund which was to be kept for 30 or 33 years, and then it was to be repaid to them under the name of redemption of capital, so that they would practically repay their own capital out of their own pockets. He suggested that it would be better for them to keep their money in their own pockets rather than leave it with the company to be redeemed at such a lengthened period.

Mr. Boulnois, in supporting the amendment, said that any shareholder, if he so pleased, could make his own redemption fund out of his dividend.

Mr. W. H. Hutchinson thought that it was unfair to burden the present shareholders with the creation of such a large reserve as was proposed. If the directors issued the shares at a small premium he thought the shareholders might be willing to accept it.

Mr. Holder said that it might be a very excellent thing for the founders' shareholders if the proposed issue was made at a premium, but he thought that it would be a most unfair thing to those who had bought their shares in the market and paid £17 for them.

Mr. Walter Leaf (a director) said that so far as he knew the intentions of his colleagues, their idea was to put the reserve fund into the business and use it, but they claimed a free hand with regard to that reserve fund. There were many uses to which it might be put. Suppose they had a bad accident or a fire at their station, as prudent men they ought to have a large reserve fund on which they could draw in such a contingency if necessary. It must be remembered that all the directors were shareholders, and it would be a very nice thing for them to put many thousands of pounds into their own pockets, and those of their friends and the shareholders. They could do that simply by issuing the shares at par, and if they did not do so, the shareholders must believe at least that they were disinterested, and that they had very serious convictions on the subject. There was the question of competition, which they must not ignore. The question of issuing the shares at par was one which the directors considered absolutely vital. They had been asked to name the price at which they would issue the shares, but they could not do that, for they did not know yet when the money would be required. There was not the slightest doubt that they intended to issue them so as to give the shareholders a substantial return of profit, but beyond that he could not go.

Replying to a shareholder, the Chairman said that the directors had received proxies in favour of their policy to the extent of £21,306, and proxies had been sent in against the directors to the extent of £9,500.

The Chairman briefly replied upon the discussion, and upon a show of hands the report was adopted by 26 to 21 votes.

Subsequently special resolutions were passed as follows:—

"That the capital of the company be reduced from £300,100, divided into 20,000 preference and 40,000 ordinary shares of £5 each, and 100 founders' shares of £1 each, to £300,000, divided into 20,000 preference and 40,000 ordinary shares of £5 each, by cancelling the 100 founders' shares of £1 each."

"That the Bill introduced into Parliament intituled 'A Bill to empower the St. James's and Pall Mall Electric Light Company, Limited, to acquire lands and erect generating stations, and for other purposes,' a copy of which has been submitted to the meeting, be and the same is hereby approved subject to all such additions, alterations and variations as Parliament may think to make therein or sanction."

Central London Railway Company.

The report of the directors of the Central London Railway Company for the half-year ended December 31st last, to be submitted to the seventh half-yearly general meeting, to be held in London on 15th inst., states that the expenditure for the half-year has amounted to £371,568, the total to date being £2,445,077. A further call of £2 per share was made, payable on January 13th last, and since the close of the year the Electric Traction Company have been paid thereout the cash amount due to them under the contract for work done to December 31st last as certified by the engineers. The engineers report that the main line and station tunnels are completed, with the exception of 100 yards which remain to be constructed at the Bank Station. The lift shafts are sunk at this point, and the roof of the public subway is now being put in. The low-level subway connecting the Lombard Station of the City and South London Railway Company with the Bank Station is complete. Substantial progress has been made with the power station and depôt at Shepherd's Bush, and the large buildings necessary for the rolling stock and electric machinery are approaching completion. A considerable portion of the generating plant has been delivered, and its installation will shortly be commenced. At several of the station sites building operations are in progress, and the erection of the electric lifts is in hand. The materials for the permanent way are in course of delivery and the rails are being laid down. Having regard to the special difficulties, entailing material delay in completing the large underground station in front of the Mansion House, the board have deemed it advisable to apply to Parliament for an extension of the time allowed for the completion of the works and for an increase in the sum authorised to be paid as interest to the proprietors during the construction of the railway. A Bill extending the time for one year from June 30th next will be submitted to the proprietors at the special meeting to be held after the conclusion of the ordinary meeting. The directors record with sincere regret the death of Sir John Fowler, Bart., who was one of the engineers of the company.

Cambridge Electric Supply Company, Limited.

The report of the directors to be presented at the ordinary general meeting of the company, to be held at the company's offices, Thompson's Lane, Cambridge, on Friday, February 17th, 1899, at 12 o'clock noon, states that the prospects of the company continue to be satisfactory. During the year 1898 there has been added to the company's mains, the equivalent of 3,885 8-candle-power lamps, making the total 25,080. The number of units supplied has been 260,307, an increase of 38,800 or 17 per cent., 36 new consumers have been added, making the total 365. There has been a general increase all round in the company's extension of mains, the capital expenditure for the past year has been £3,035 13s. 7d.; 16,706 yards of pipe and cable have been laid down, and the duplicate system of distribution referred to in last year's report is on the point of completion. The company after paying all charges, placing £250 to the reduction of preliminary expenses, £300 to depreciation account, and £84 1s. 7d. to the credit of suspense account, has a balance of £3,037 9s. 11d., which, added

to £292 16s. 10d. brought forward from last year, makes £3,330 6s. 9d. An interim dividend of £1,068 9s. 3d. and interest on temporary overdraft £71 0s. 3d., have already been paid, leaving a net balance of £2,190 17s. 3d., out of which the directors recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £2,067 5s. 6d., leaving a balance to carry forward of £123 11s. 9d.

Newcastle and District Electric Lighting Company, Limited.

The report of the directors of the above company states that the supply of current continues to give satisfaction to the company's consumers. The installations connected to the company's mains during the year are equal to 3,678 10-candle-power lamps, bringing the total up to about 36,278, and 778,828 units of electrical energy have been supplied, as against 642,969 units supplied in 1897. During the past year 2,563 yards of main and branch piping have been laid, together with 10,326 yards of main and branch cable. The gross earnings during the year amount to £7,516 0s. 1d., and after paying interest, and making provision for depreciation, the directors are able to recommend a dividend of 5 per cent. for the half-year ending December 31st (less income-tax), which, together with the interim dividend paid in August last, makes the dividend 8½ per cent. for the year. Sir B. C. Browne retires by rotation, but is eligible, and offers himself for re-election as a director. The auditors, Messrs. Strachan and Co., also offer themselves for re-election.

National Telephone Company, Limited.

The report for the half-year ended December 31st states that the income of the half-year amounted to £573,707, as compared with £507,602 for the corresponding period of 1897. The expenses amounted to £312,462, as compared with £283,085, and the net result for the half-year (after deducting the Post Office royalties, amounting to £54,356) is a profit balance of £206,888, as compared with £178,457. The rentals carried forward for unexpired terms of running contracts amount to £536,654, as compared with £473,586. Out of the available balance the board recommends a dividend at the rate of 6 per cent. per annum, less tax, on the first and second preference shares, 5 per cent. per annum, less tax, on the third preference shares, and 6 per cent. per annum, tax free, on the ordinary shares. The board also proposes to transfer £50,000 to reserve, and to carry forward £8,287. The sum of £367,901 has been expended on capital account during the half-year in the erection of 6 932 additional exchange and private lines and in the construction of underground lines.

Great Northern and City Railway Company.

The half-yearly meeting of this company was held on Tuesday last at the Westminster Palace Hotel, Sir Charles Scotter in the chair.

The Chairman said that it was now nearly nine years since the first Parliamentary powers were obtained for making the railway, but no efforts appeared to have been made to raise the capital until 1894. The application to the public at that time was not successful, and the scheme was allowed to remain in abeyance for some time. Applications had, however, been made to Parliament and granted for extension of time and other powers, and the line was to be completed by the end of June, 1902. Although he was fully acquainted with the scheme as originally submitted to Parliament he had no connection with it until the beginning of last year; and, having carefully looked into the evidence given before Parliament, he had come to the conclusion that there was no underground electric scheme in London at the present time which had more justification for its origin, or which offered better prospects of ultimate success. It would not be dependent upon a limited area for its traffic, but it would practically be the City terminus of the Great Northern Railway, and the railway itself ran through and would accommodate a district which was said to be the most densely populated part of London. The Great Northern Railway Company were by agreement bound to run a *minimum* of 50 trains each way per day, and he would not be surprised to find that number largely increased when the line was opened for traffic. The growth of the Great Northern suburban traffic was phenomenal, and Sir Henry Oakley, when supporting in Parliament the Bill for the making of the railway, stated that it increased at nearly one million per annum. The railway differed from other electric railways in the fact that the tunnels were larger and quite capable of taking the Great Northern rolling stock without difficulty, so that their suburban traffic could be efficiently worked to and from the City in through trains and in much less time than by any existing route. When the first prospectus was issued by him and his colleagues last June they did not go to allotment, because the amount subscribed did not reach £1,000,000 — the *minimum* sum they had fixed as that which would justify their proceeding with the railway. Some people thought that they were too cautious, but that was the directors' determination, and therefore they returned the amount subscribed. A few weeks later, thanks in a great measure to the influence and perseverance of Sir Henry Burdett, arrangements were made which secured the necessary funds, and the prospectus was advertised again for one day only, with the result that on July 20th last the directors went to allotment with more than £1,000,000 of share capital subscribed, divided amongst about 400 shareholders. As to the construction of the railway, a contract had been entered into with Messrs. S Pearson & Son, Limited, to carry out all the works and equipment for the line at a lump sum, they taking all the risks. The engineers were Sir Douglas Fox and Mr. Francis Fox, from whom they had received a report upon the progress of the works, dated the 6th inst., which stated that at the Regent's Canal the contractors were in the possession of all the necessary houses, except one, for the temporary purposes of their yard and for the permanent generating station. The working shaft at that point had been sunk to its full depth—namely, 53 feet from the surface, and the heading to give access thence to the railway tunnels was being started. The foundations for the electric light engine and air compressor were in place, and some of the machinery had been delivered on the ground. The construction of the special shields for driving the tunnels was well in hand, and they would be quite ready by the time the heading reached the centre line of the railway. They did not look upon the Bill which the Great Northern directors were promoting for the construction of an electric railway from Wood Green to King's Cross as in any way a competitor to their line. In his judgment the only way to do away with the enormous congestion of traffic in the streets of London was by piercing London throughout with electrical railways.

Sir Allen Sable seconded the motion, which was adopted.

Stock Exchange Notices.—The Stock Exchange Committee have appointed special settling days as under:—Wednesday, February 15th.—Costa Rica Electric Light and Traction Company, Limited—£130,000 5 per cent. first debentures, Nos. 1 to 1,000 of £100, and 1,001 to 1,600 of £50 each. Wednesday, March 29th.—Illinois Car and Equipment Company—€0,832 shares of $25 each, in certificates of 10 shares, and have ordered the same to be quoted in the Official List.

W. T. Henley's Telegraph Works Company, Limited.—Subject to audit the directors recommend a dividend on the ordinary shares at the rate of 12 per cent. per annum (including the interim dividend of 4 per cent. already paid) and a bonus of 2 per cent. per annum, less income-tax, payable March 1st.

Eastern Telegraph Company, Limited.—At an extraordinary general meeting held on Wednesday at Winchester House, Mr. J. Denison-Pender presiding, the resolution which was passed at a previous meeting was confirmed. The resolution was for altering clause 29 of the articles for association.

City of London Electric Lighting Company, Limited.—The directors recommend a final dividend on the ordinary shares of 3½ per cent. on the capital paid up, making a total dividend of 6 per cent. for the year ended December 31st.

Telegraph Construction and Maintenance Company, Limited.—The directors propose paying a dividend of 10 per cent. (£1 4s. per share) in addition to the 5 per cent. already paid, making 15 per cent. for the year 1898.

Brush Electrical Engineering Company.—The directors have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares for the half-year ended December 31st last.

W. T. Glover & Co.—The transfer books of this company will be closed from the 4th to the 17th inst.

Waterloo and City Railway Company.—The meeting of this company was held yesterday afternoon, when the report was adopted and a 3 per cent. dividend declared. A report will appear next week.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending February 4th, 1899, were £172 18s. 5d.; aggregate to date, £737 15s. 6d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending February 3rd, 1899, were £3,274 12s. 8d.; corresponding period, 1898, £2,276 0s. 8d.; decrease, £1 8s.

The City and South London Railway Company.—The receipts for the week ending February 5th, 1899, were £1,135; week ending February 6th, 1898, £1,063; increase, £72; total receipts for half-year, 1899, £6,688; corresponding period, 1898, £6,456; increase, £232. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending February 4th, 1899, were £124 19s. 6d.: week ending February 4th, 1898, £101 0s. 5d.; increase, £23 19s. 1d. Total receipts to date, 1899, £711 18s. 7d.; corresponding period, 1898, £598 0s. 8d.; increase, £178 17s. 11d. Miles of track open week ending February 4th, 1899, 3; week ending February 4th, 1898, 2. Car miles run week ending February 4th, 1899, 4,265; week ending February 4th, 1898, 2,581. Number of cars, week ending February 4th, 1899, 11; week ending February 4th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, February 3rd, 1899, were as follows:—D. U. T. Co., horse cars, £1,693 10s. 11d.; ditto, electric cars, £826 10s. 11d.; D. S. D. Co., electric cars, £551 2s. 7d.; total, £3,071 4s. 5d.; corresponding week last year—D. U. T. Co., horse cars, £2 611 1s. 3d.; ditto, electric cars, £116 14s. 7d.; D. S. D. Co., electric cars, £396 17s. 9d.; total, £3,124 13s. 7d.; decrease, £53 9s. 2d; aggregate to date, £15,421 13s. 9d.; ditto last year, £15,659 8s.; decrease to date, £237 14s. 8d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways. — The receipts for the week ending January 18th, 1899, were £233; total receipts to date, 1899, from June 29th, 1898, £7,589. Miles of track open, 3¼. Car miles run, 3,995. Number of cars, 10. Week ending January 25th, 1899, £295; total receipts to date, 1899, from June 29th, 1898, £7,884 Miles of track open, 3¼. Car miles run, 4,929. Number of cars, 10.

The Liverpool Overhead Railway Company.—The receipts for the week ending February 5th, 1899, amounted to £1,278; corresponding week last year £1,283; decrease, £10.

The South Staffordshire Tramways Company.—The receipts for week ending February 3rd, 1899, were £587 8s. 4d.; aggregate receipts for five weeks, £2,895 14s. 2d.; week ending February 4th, 1898, £608 15s. 9d. aggregate receipts for five weeks, £2,957 12s. 5d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Feb. 1st.	Closing Quotation, Feb. 8th.	Business done during week ended Feb. 8th, 1899. Highest.	Lowest.
124,400*l*	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	102	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	...
905,560*l*	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	68 — 70	68 — 70	68⅛	...
3,047,220*l*	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	120 —121	120 — 121	120½	120
3,047,220*l*	Do. do. Deferred...	Stock	...	...	18s. %	16½— 17	16½— 17	16⅜	16½
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	...	15⅝— 16¼	15⅝— 16¼	16 3/16	16
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	180 —190	180 —190	...	...
1,332,523*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105¾	105½
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	...	...	1/8— 3/16	1/8— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	9½— 10½	8½— 9½	8¾	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17 — 18	17 — 18	...	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	104 —107%	104 —107%	...	...
60,710*l*	Direct United States Cable	20	2½ %	...	...	12½— 12¾xd	12½— 13	12⅝	12 7/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —105	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	175 —180	177 —182	181	175
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	103 —106	103 —106	105½	104
500,000	Do. Prov. Certs., all paid	...	...	...	...	103 —106	103 —106	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	99 —102 xd	99 —102	100	...
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	125 —129	125 —129	127½	125½
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	17¾— 18¼	17¾— 18¼	18⅛	17¾
16,200*l*	{ Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326 }	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	124 —128 xd	124 —128	124½	...
35,100*l*	{ Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	...	...	99 —103	99 —103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —106 xd	102 —105	...	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	...	12⅜— 13¼xd	12⅜— 13¼	13½	12⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	16¾— 17¼xd	16¾— 17¼	17 3/16	17⅛
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	29 — 30	29 — 30	...	...
150,000*l*	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	...	101 —104	101 —104	...	...
97,800	Halifax & Bermuda Cable, 4½% 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	99 —103	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	58 — 61	58 — 61	60¾	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	109 —112	109 —112	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	6 %	6 %	5¾— 6	5¾— 6	6	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	15⅝	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅝— 5⅞	5⅝— 5⅞	5⅞	5 11/16
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —102	99 —101	100⅛	99½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝— ¾	⅝— ¾	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	104 —107	104 —107	99½	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	7	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	136 —141	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	5⅛	...
151,733*l*	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	104 —107	106	...
200,000*l*	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
64,269	Western and Brazilian Telegraph	15	2 %	3½ %	...	12½— 12⅝	12½— 12⅝	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	8 — 8½	8 — 8½	8⅛	...
33,129	Do. do. do. Def. Ord.	7½	nil	½ %	...	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —108	105 —108	107½	...
88,321	West India and Panama Telegraph	10	1 %	¾ %	...	1½— 1⅝	1½— 1⅝	1 11/16	1 5/8
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¼— 10¾	10¼— 10¾	10½	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	8½— 9½	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	104 —107	104 —107	...	...
158,100*l*	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11 — 12	11 — 12	11 1/16	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	...	9 — 10	9 — 10	...	...
60,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	113 —115	114 —116	115	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	7 %	10 %	6 %	23½— 24½	23 — 24	23⅞	23 3/16
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	22 — 24	22 — 24	22⅞	22⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15½— 16½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	nil	nil	...	12½— 13½	12½— 13½	13⅛	12⅜
10,000	Do. do. do. Nos. 30,001 to 40,000 ...	10	...	...	...	12 — 13	12 — 13	13	12¾
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	14½— 15½	14½— 15½	14⅝	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5 — 5½	5 — 5½	...	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	4 %	...	9 — 10	9 — 10	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9½— 10½	9½— 10½	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3⅝— 4¼	3½— 4	3⅞	...
48,050	Do. do. do. 6 % Pref.	5	...	...	...	6½— 7	6½— 7	6⅞	6⅝
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	103 —105	103 —105	105	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	...	19 — 20	18½— 19½	19⅜	18 13/16
22,500	Do. Nos. 62,501 to 85,000, £4 paid ...	10	...	...	...	12 — 13	12 — 13	12	...
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	118 —121	118 —121	120½	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	...	17 — 18	17½— 18½	18½	18
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	17 — 18	16½— 17½	17½	17⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9⅞	9 1/16
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3⅜— 3⅝	3⅜— 3⅝	3½	3⅜
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	15½— 16½	15½— 16½	16	15

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Feb. 1st.	Closing Quotation Feb. 8th.	Business done during week ended Feb. 8th, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3 — 3½	3 — 3½	3 5/16	3⅛
90,000	Do. 4¼ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	...	...
30,000	British Electric Traction	10	...	...	...	17½— 18⅛	17 — 18	17 11/16	17 7/16
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13½— 14	13½— 14	13 13/16	...
100,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —122	120 —122	121½	...
90,000	Brush Elecl. Engng., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	2	1 15/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000‖	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	101	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	9½— 10½	10½— 11½	11¼	10¼
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	110 —113	110 —113	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅞— 10¼	9⅞— 10¼	10⅛	9 15/16
178,303	Do. do. do. £8 paid	10	...	...	...	7⅞— 8¼	7⅞— 8¼	...	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3½— 4	3½— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4 — 4½	4 — 4½	4½	...
630,000‖	City and South London Railway	Stock	1 9/16 %	1⅞ %	2⅛ %	69 — 71	71 — 73	72	70½
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	3½— 4	4⅜— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	2½— 3	2⅞— 3⅛	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	98 —101	98 — 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½ %	6 %	...	2½— 3	2½— 3	2 7/8	2 9/16
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½ %	6 %	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	97 — 99	99	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2¼— 2¼xd	2¼— 2⅜	2⅜	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	3½	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —105	103 —105	104½	103
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	3/8— 5/8	3/8— 5/8	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600‖	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	24½— 25½	25 — 26	25 7/8	24 7/8
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	18½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	110 —115	111 —116	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	22 — 23	22 — 23	22 7/16	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞ %	3½ %	3¾ %	10½— 10¾	10½— 10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14¾— 15¼	14¾— 15¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	40½	39
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	8½— 9	8½— 9	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5¾— 6¼	6⅛	...
540,000‖	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	109 —112	109 —112	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—12; 7 % Pref., 11—12.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—14; 1st Preference Cumulative 6%, £5 (fully paid), 7⅜—8¼. Debentures, 107—110%. Dividend, 1897, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 8/6 to 9/6.
Smithfield Market Electric, 4¼—4⅜.
*T. Parker, £10 (fully paid), 15½.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, February 8th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a " Nitric .. .. .. per cwt.	22/-	22/-	..
a " Oxalic .. .. .. per cwt.	32/-	32/-	..
a " Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a " " (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a " (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£24	£22 10	30/- inc.
a Lead, Nitrate .. .. .. per ton	£23	£23	..
a " White Sugar .. .. per ton	£30 10	£30 10	..
a " Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a " Caustic (75/80 %) .. per ton	£24	£24	..
a " Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	67/-	67/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a " Recovered .. .. per ton	£5 15	£5 15	..
a " Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a " Crystals .. .. .. per ton	£3	£3	..
a " Bichromate, casks .. per lb.	3d.	3d.	..

Quotations supplied by Messrs. G. Boor & Co.
" " " The British Aluminium Co., Ltd
" " " Messrs. Thos. Bolton & Sons.
" " "
" " "
" " " The India-Rubber, G.-P., and Teleg. Works Co Ltd
" " " Messrs. James & Shakspeare
" " " " Jackson & Till.

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b " Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2" to 12") basis per lb.	8¼d.	7⅞d.	⅛d. inc.
c " Tube (brazed) .. .. per lb.	10d.	9⅞d.	⅛d. inc.
c " Wire, basis .. .. .. per lb.	8¼d.	8d.	¼d. inc.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f " Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£79	£79	..
g " Wire (basis price) .. per lb.	9⅝d.	9d.	⅝d. inc.
g " Sheet .. .. .. per ton	£79	£79	..
g " Rod .. .. .. per ton	£79	£79	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	only 3 tons obtainable
h India-rubber, Para fine .. per lb.	4/1½ to 4/2	4/3	1½d. dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i " Pig (Cleveland warrants) per ton	47/9½	47/8	1½d. inc.
i " Forgings, according to size per ton	From £11	From £11	..
i " Scrap, heavy .. .. per ton	50/- to 55/-	45/-	5/- inc.
i " Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£15	£15	..
g " " Sheet .. .. per ton	£15 15	£16	5/- dec.
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8 5	..
o Platinum .. .. per oz.	£3 6 6	£3 6 6	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£115	..
g " foil .. .. per lb.	1/6	1/6	..
n " wire Nos. 1 to 16 .. .. per lb.	1/6	1/6	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¾d.	6¾d.	..
j " Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j " Hemp, 8 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j " " Russian, 10 lbs. per lb.	4½d.	4½d.	..
j " Jute, 180 lbs. rove .. per ton	£12	£12	..
j " Manila, 24 thread .. per ton	£30	£30	..
k Zinc, Sheet (Vielle Montagne bnd.) p. t.	£31	£30	20/- inc.

i Quotations supplied by Messrs. Bolling & Lowe.
j " " " " Henry C. Yeo & Co.
k " " " " Morris Ashby, Limited.
l " " " " Sanders, Wake & Co.
m " " " " W. T. Glover & Co., Ltd.
n " " " " P. Ormiston & Sons.
o " " " " Johnson, Matthey & Co., Ltd.

ACCELERATION.

Lack of punctuality on southern lines is chiefly caused by mental rather than by material causes. It must be a matter of common observation of travellers that, though a train may be running half an hour late, there is no particular despatch observed to get away from stations. Even after the final dilatory signal has been given, the driver uses no effort to get his train in motion, nor, when in motion, does he put the engine into full gear to accelerate the train rapidly. On all the southern lines, after the signal has been given to start, there is first an appreciable wait; next comes a tardy whistle; in a little time there is a distinct tremor in the train, and soon after it begins to move slowly, not always forwards, often backwards, for a short distance. When finally it does move forward the movement is very leisurely, and no speed is got up, though the engine is powerful enough for rapid acceleration. Now let this be compared with the method of the Lancashire and Yorkshire Railway. At one time this line was a bye-word for unpunctuality and general bad management. It is even doubtful if the Chatham and Dover is to-day much worse than the Lancashire and Yorkshire in its bad days. This is now changed. In starting a train on that line, and other of the northern lines, we have observed that the driver watches for the signal to start, and has practically put the throttle lever over before this signal is even complete. The train moves before the whistle sounds, the driver sounding this as soon as he has given the engine steam. Acceleration is rapid, and the engine runs in full gear until speed is considerable, when the link is moved to a more economical position. Now this brisk movement comes not from below, but from the board room. Punctuality is made a serious matter, and from top to bottom men are made to feel they have got to be punctual. It is largely a question of quickness of mind and promptitude of habit. Where punctuality is not demanded by the directors, laxity prevails all the way down. We have before us as we write an answer of a southern railway manager to a complaint of unpunctuality. The complainant is practically told he is not speaking the truth, and the extraordinary claim is put forward that on some occasions the train arrived before its time, as though a plus unpunctuality could balance a minus unpunctuality.

Now this habit of unpunctuality is at once a cause and an effect of absence of the faculty of appreciation of acceleration.

Railway people complain that trains are late because of bicycles. They demand exorbitant rates of carriage of bicycles, yet they provide no accommodation for them, and waste time packing them in amongst trunks and boxes instead of in a proper light truck. They economise on vehicles because they have not the mental faculty of appreciating acceleration and its sister virtue of punctuality. On the better railways it is always the trains which are compelled to strain every nerve to accelerate rapidly in order to keep time, that do keep time best. In America the same thing is noticeable. It is only on the slow western way trains that there is sometimes a day's lateness. The fast trains of America are models of punctuality, and with the growth of electric traction on tramways there has sprung up a keen appreciation of the importance of rapid acceleration; so keen, indeed, that the power of the electrical motors is many times that necessary simply to run the car at speed, and many times what would be given by horses at their utmost strain.

Americans have discovered that it is better and more economical to accelerate a train to the maximum in the minimum of time and then to run by momentum to the braking point than it is to accelerate more slowly. The economical idea is to attain speed by utilising the utmost adhesion of the wheels by means of powerful motors. Acceleration pays if done rapidly, and the grip obtained by Americans of this essential point has given them a length of electrical lines about 230 times as much as we possess in England. If the County Council of London contained men of the right training to perceive the truth in respect of acceleration, the facts which would then be patent to them would be sufficient to overbalance the objections which now loom so big. The County Council of London is not composed of bad and wicked men, as one would suppose to hear its condemnation, save and except ignorance may be called crime. It is simply ignorance which makes this body appear so sinfully wasteful of the public time in refusing facilities for travel. Its members have no qualification as engineers; they could not understand an explanation of the simple dynamics of acceleration.

It is much to be regretted that those responsible for the Waterloo and City line should not have taken care that the motive power supplied was sufficient for the load. There is no excuse for this mistake. The requirements of power for cars of a given weight on a given incline are perfectly well known, yet insufficient power is supplied somewhere in the chain. The deplorable ignorance of the majority of writers on the daily press has something to do with the standstill condition of traction, especially in London. London people are apt to believe that London heads the world in all things. Now, in all matters of transportation, London is deplorably behind the smallest towns in the country. There is no rapid transport in London. The steam railways to the suburbs do not average over 15 miles per hour as a certainty; that is, a passenger can never feel reasonably certain of arriving at his destination in less time after advertised times of departure than this speed represents. Street traffic is so congested, that a cab is of little use for a man in a hurry. Omnibuses are no better. A suburban electrical tramway service would, if properly managed, tend to cure one of the above evils, as it would so diminish railway receipts as to rouse the shareholders to a sense of the incapacity of the present management. Electrical vehicles would do much to ease the traffic in the City and crowded thoroughfares, for electrical vehicles are not more than about half as long as horsed vehicles. There is one objection to the tramway to the suburbs. It cannot run into the City on the surface, and if laid all the way in a buried subway, the cost would be, perhaps, prohibitive. For a suburban service, a mixed system seems likely to be successful, tunnels to the limit of crowded traffic gradually rising to the surface, and proceeding thence by the roads.

The roads out of London are, on the whole, fairly good and wide; but there is a system which has never been broached seriously in this country, yet which at one stroke abolishes all the dangers which high-speed surface cars introduce—and it cannot be doubted that the high speeds of American tramway vehicles are responsible for many deaths. We refer to the overhead system as employed in New York, Chicago, and Brooklyn. For suburban traffic the elevated railway is an ideal one. Indeed, what is every railroad out of London but an elevated line of the worst type? The proper type of elevated railway is that employed for the docks line at Liverpool—a structure of steel girders.

No structure of this type could develop anything so hideous as the dark dungeons which constitute the lower purlieus of such stations as Ludgate Hill, Brixton, and, last and worst, Loughborough Junction. People execrate the elevated railway idea. Yet in all New York there is nothing to compare in unsightliness with the lines from Holborn to Herne Hill, from London Bridge to New Cross, or to Charing Cross, or from Victoria to points across the river. In fact, all railways out of London are run on heavy black light obstructive viaducts of brick which conceal noisome dens beneath them. Who can deny that a steel viaduct on posts would be infinitely more healthy in every sense.

Electrical lines do not drop cinders and hot water on people below, and one of the annoyances of the elevated railroad is wiped out at once. Privacy of dwellings is fully as much invaded by every suburban line at present as ever it could be by the L type of line. Probably if everyone would think out this question for himself, the conviction would be forced on him that the terrors of the L road are largely imaginary. With no sulphurous smoke from locomotives there would be no nuisance from the motive power. Structurally but little fault can be found, and generally it must be admitted that the evils of our present means of transport have become so great that something must be done to ameliorate them or to provide services which can be accelerated. Business is being hindered seriously in a way to which no other nation is subject. Londoners lose at least one hour every day on the average by railway slowness and unpunctuality, and thousands of appointments are lost and much friction generated by the faults of the railways.

It seems to be assumed that an elevated railroad must necessarily be run over the main streets in front of the houses. This by no means follows. They could equally well run, as do the existing steam railroads, at the backs of houses, or even over them. The conversion of some of the suburban embankments, now existing, into steel viaducts, would probably be paid for by the land saved. The cost of steel viaducts will be far less than that of buried tunnels, which alone suggest themselves to most people as the only solution of London's troubles. We are convinced that the elevated steel viaduct of openwork description has not received the careful consideration of thinking men.

It is time something was done, for the matter has become vital. Want of transportation has reached the stage of a public scandal.

THE METRICAL SYSTEM.

It is desirable that all engineers should have a knowledge of the metrical system, and if we are to believe the many who are accusing the English system of weights and measures, England and America are in a fair way to losing their places as nations, because they do not use the metre. It is a little curious to find that the advocates of the metrical system all hark back to rods, poles, or perches, kilderkins and firkins, stones and hogsheads, and so on, as arguments against the English system. Now, it is just these old-fashioned and curious measures which are not used in engineering, and the present writer does not know, nor can he recollect ever to have known, what a firkin or a kilderkin represents. If used at all in English trade, such old measures are used in the provision trade, and the foreigner who supplies our markets very soon acquires all the knowledge necessary of firkins, nor do we hear of the Danish Government howling for the change of all the Danish measures into English to save the Danish butter trade from ruin. Yet that is what is wanted if arguments cut both ways. If English manufacturers wish to sell things abroad they will, no doubt, make such use as is necessary of foreign measures. If a salesman is fit to go out to sell, why not give him an extra hour some day for luncheon, so that he may acquire the knowledge of such metrical measures as may be necessary for him to know. An excellent article appears in *Machinery* from the pen of Mr. Jno. E. Sweet, than who few write more sensibly. He is strongly against the metrical system which is being again exploited in America. As to the argument that only England, America and Russia, use the old system, he points out that these three countries represent a good half of the civilised world, and do as much measuring and weighing as all the other people put together. Mr. Sweet points out that, though the United States have a decimal coinage, they divide their standard dollar in halves, quarters, and have only two decimal sub-divisions, the dime of 10 cents and the cent itself, while the 10 cent is divided into half as a nickel, and the cent is doubled and trebled to give the 2 c. and 3 c. Americans practically use the 5-dollar bill, value one sovereign, the dollar or double florin, the half-dollar or florin, the quarter, equal to one shilling, and the cent or half-penny. On 'Change the cent is divided binarily into

as small a division as the sixteenth, whereas on the decimal system the $\frac{1}{10}$ c. is too big, and the $\frac{1}{100}$ c. is too small. Tenths are poor divisions to mark on a scale beam, and Mr. Sweet shows that even in France, as we ourselves have found, the metrical system is not used by the people as a mass. We have purchased fruit there by the *livre* at so many *sous*, and even when the kilogramme is used, it is divided into binary divisions; but the half kilogramme is the unit, and one hears goods ordered to the amount of a quarter of half a kilogramme. We ought to be very certain that a right step is being taken before abandoning our own simple measures.

Practically, engineers have one measure, the inch, and it might be desirable to abolish the foot on drawings. Americans give a boiler diameter in inches, just as we do even the largest marine cylinders, and the foot may often be abolished in favour of a statement in inches. In the metric system this cannot be done so well. Either the standard metre must be given as a decimal, or the decimal point must be cut off, and the letters *mm.* added, which is fully as confusing as the foot and inch system. The chief points where the English system may perhaps be called cumbersome, are, as pointed out above, in directions which do not affect foreign trade. Thus we may cite the acre and the mile and the square mile as perhaps a little cumbersome, but what can be simpler than the inch. As regards foreign trade, it is easy enough to print catalogues in both systems. Mr. Sweet says it would be far easier and simpler for all nations to change to the English system, as half of them really have it already and use it considerably. He adds, "As they will in time to the English language."

He refers to the time, now 15 years ago, when Dr. Coleman Sellers put a stop to the "pestilence" now again threatening the industries of America. He did it in a 20 minutes' essay, and we have yet to see a really good advocacy of the metrical system. Even as regards chemistry it is not so very important to use the same system of weights as in engineering. In engineering calculations involving chemistry men as a rule work out on the ratio of combining weights, and having found the ratio they very soon find the ton rate. Say it is a problem in water softening, this is purely a question of atomic weights, and unfortunately for the bowl for a natural system, the atomic weights of elements are a very mixed lot indeed; fractional numbers which are approximated for use as whole numbers, and that natural science of chemistry certainly takes small note of the decimal system, as a glance at a series of the carbon compounds will soon show.

If we take the principal elements, we find them multiples of 2 as regards their atomic weights. We have H = 1, O = 12, N = 14, O = 16, S = 32, Ca = 40, Fe = 56. Here we have the chief elements of use to man, to whom nature has given relations which indicate a binary system, and it appears far more useful to embody a binary system of division than it does to make such a fuss about a so-called scientific system based (erroneously, however) on the ten-millionth of the quadrant. All measures of length among civilised nations are, after all, the distance between certain marks on a carefully tended bar of metal. If lost or accidentally injured, the standard cannot be accurately replaced, though there are now so many practically accurate copies that no serious error could creep in. As regards correlation of weights and measures, have we not our gallon of 10 lbs. of water?

Now, in the metric system the cubic decimetre is supposed to contain a weight of water of standard weight to be called a kilogramme. As a fact, does it do so? We believe not. The actual kilogramme itself is a lump of metal weighed at Paris. We think had the metrical system not been based on a decimal division, some general acceptance would have been secured ere this. It is the decimal inconvenience which damns it—an inconvenience not felt in scientific work where a tail of figures after a decimal point is of no moment. But it will not serve the people at large, and we should still have two systems in use as now, even if the metrical system were made in a sense compulsory. We cannot think that those doing business in metrical countries will find much difficulty in suiting their goods and tests to the people. Substantially, a 30-inch cylinder has a diameter of 0·762 m., and no one is injured by using this approximation. The actual value of 30 inches is 761·9931, 24 inches measures 610 mm. Actually, it is 609·594, and again no one is injured at the approximation, for in case of an actual professorial steam test, of neither the makers' inches nor millimetres would any cognisance be taken, but the cylinder would be gauged and its diameter given to a string of decimals, and perhaps the expansion by heat would as usual be neglected. Yet a 30-inch cylinder, hot and cold, may vary $\frac{1}{20}$th of an inch, or more than a millimetre, or sufficient to alter results to the extent of a third of 1 per cent. We think young engineers should familiarise themselves with the metrical system for many reasons. They will easily do this in the course of their studies in chemistry, and all engineers will find the task easy. The confusion which the advocates of the metre endeavour to conjure up does not exist with engineers, but we strongly suspect it will prove insuperable to the bulk of the populace, as it has done to the French people themselves.

AN EXPERIENCE OF MOTOR HAULAGE.

The firm of Fox Bros., of Wellington, Somerset, and of Uffculme and Culmstock, in Devon, are extensive manufacturers, and have to do a considerable amount of haulage between their various works, the railways having been found wanting in punctuality of delivery. One mill, that at Uffculme, is 9 miles from headquarters, and the goods conveyed are chiefly wool, bobbins, and skips; loads being rather bulky than heavy in one direction, but more compact on return. The Culmstock mill is 6 miles away. Taunton, 7½ miles distant, is a town whence heavy loads of stuff are brought, but the road is a good one, both as to surface and gradients. The other roads, however, are mostly typical Devonshire lanes, rough, uneven, and narrow, with gradients as steep as 1 in 7½, but mostly about 1 in 10. Two pair-horse teams, with most of the time a fifth horse, were employed on the work, and they had a short working life. A description of what they did to alter their tractive power is described by the firm's engineer, Mr. S. H. Sparkes, in a recent paper read to the Liverpool Self-Propelled Traffic Association.

The vehicle selected was that of the Lancashire Steam Motor Company. The first vehicle weighed some 7 or 8 cwt. over 3 tons, and was finally rejected because of this, and a new one was built to come within the 3 tons limit. We need not reproduce the somewhat exciting experiences of breakdowns and ditchings which marked the early trials, but the results have convinced Mr. Sparkes that 3 tons is too light a weight to permit of suitable proportions and strengths and desirable margins of safety. Another half ton of material would do much towards securing more reliable results if properly distributed.

However, the old and the new waggons have made a mileage of 1,632 and 1,774, during which they have carried 418 and 675 tons, being an average load per journey 1·85 and 2·47.

The oil consumed in the boiler fire was 3,881 gallons, or 0·52 gallons per ton-mile of load, including getting up steam, and also yard shunting, which is not included in the mileage figures. High as this may seem, it is to be noted that over 800 miles were travelled without load, and the roads are very bad. Oil cost 5½d. per gallon, and is more costly than best picked Welsh coal, but less has to be carried; it is cleaner, and more convenient. Coal would probably cost 15s. or 18s. per week; oil has cost 45s., but coal would require a second man, which, however, would still leave a margin in favour of mere cost of coal. The second man, however, might be useful in breakdowns.

Front tyres are 5 inches wide and back tyres are 6 inches, these being 1 inch wider than originally applied, and producing less effect on the roads than horse waggons. Many miles have been done over loose metalling, there being no steam rolling. For such waggons as these appear to be we do not see that the tyres are wide enough. Why there should be an aim to reduce tyre widths to a minimum we never could understand, but we have always found that carts have the narrowest tyres in the districts where roads are softest and least cared for.

In testing the boiler the author found on a 2½ hours' test, with 160 lbs. steam and a fuel (? feed) temperature of 50° F., an evaporation of 765 lbs. of water by 58 lbs. of oil, or 13·2 lbs. per lb. This corresponds with an evaporation from and at 212° of about 14·5 lbs.

The annual cost, including interest at 5 per cent. and depreciation at 15 per cent. on the first cost of £375, came to £340. With a duty of 9,771 net ton-miles this comes to 8·3d. per ton-mile. With coal the estimate is 6·93d. With horses the first cost is set down as £325, the 4½ horses costing £225 of this. Interest is charged at 5 per cent. and depreciation is charged 20 per cent. on the horses and 10 per cent. on the vehicles, and the annual cost works out at £369, which shows a saving for the power vehicle. This also did nearly £20 of work never undertaken by horses at all. The net result has shown a saving of at least £50. It would have been £90 but for an exceptional accident to the boiler, and it would have been £140 if coal had been the fuel. On the whole, the experience cannot be said to have been unfavourable to power traction, for this is comparatively experimental. One can only regret that the shortsighted policy of the day put a stop to Handcock's and other steam carriages of the earlier century. Had these been allowed to take their natural development, the state of road locomotion would have been very different from what it is to-day. All trams would have been power driven, and the aid of electricity would have been easier to apply. Steam-propelled vehicles would have educated even a London County Councillor to the benefits of power traction.

It appears that wool measures about 200 cubic feet to the ton, and loads were only light, so that the average load of 2·16 tons causes a heavy ton-mile rate, especially with so much shunting work in collection. The steam motor vehicle is necessarily heavy, and has a large fuel consumption in moving itself empty. Electricity could not be applied on such little-frequented roads because of the first cost of the line, but where a pole line could be afforded there would not be the same load of vehicle to be dealt with in the case of electrical traction. For individual firms and by-roads the problem is clearly best solved by steam.

THE ELECTRO-METALLURGICAL LABORATORY AT AACHEN POLYTECHNIC.

Apropos of the remarks in our issue of January 27th relative to the better provision made in Germany for teaching electro-chemistry, the following account of the new electro-metallurgical laboratory at the "Königliche Tech. Hochschüle," at Aachen, should be of interest to our readers.*

Prof. Borchers, the present head of this department at Aachen, found upon his transfer there from Duisburg in October, 1897, only somewhat limited provision made for experimental work. Owing to the support of his colleagues and the readiness of the State education officials to do all in their power to assist this new branch of technical science, at the end of his first term of work at Aachen, he

* Abstracted from *Zeits. f. Elektro-chemie*, November 3rd, 1898.

was able to commence the alterations and additions which now make the Polytechnic at Aachen one of the best science schools in Europe for the study of electro-metallurgy.

The laboratory in which Prof. Borchers' students carry on experimental work is provided with the following motors, dynamos, and accessory apparatus:

1. A 20-H.P. electric motor by Schuckert & Cie., by which the various dynamos are driven.

2. A 8-kw. dynamo by Schorch & Co., of Rheydt, built to Borchers' specification. This machine yields 300 amperes at 20 volts, or 120—150 amperes at 70 volts.

3. Two dynamos by Siemens & Halske, one delivering 22 to 30 amperes at 70 volts, the other 100 amperes at 10 volts.

4. A 1½-kw. dynamo, by Garbe, Lahmeyer & Co., delivering 18 amperes at 90 volts.

All of these are direct current machines.

5. A polyphase dynamo by the Deutsche Elektricitäts Werke, yielding 30 amperes at 220 volts.

6. An accumulator battery of 36 lead elements, usually worked in conjunction with the Garbe-Lahmeyer dynamo.

7. A large number of electric furnaces of various types, in addition to furnaces heated by coal-gas and by oxygen.

8. Appliances and moulds for making furnace linings, and for forming the blocks of which the furnaces are built.

In addition to electric furnace work, investigations upon the electrolysis of fused salts are carried out in this laboratory. During the latter part of 1898 the students built themselves several new forms of electric furnace, and on trial some of these were sufficiently successful to warrant patents being applied for.

Further extensions and additions are in prospect in connection with this laboratory.

The above shows what is being done at *one* German Polytechnic to promote the study of electro-metallurgy. It possesses—a professor devoting himself specially to this subject, a well equipped laboratory for original work, and students who are specialising in this branch of chemistry.

In this country, after 10 years' agitation upon the subject of "Technical Education," we are still laying foundations and spending (*i.e.*, squandering) £800,000 per annum upon teaching every youth we can get into our evening classes, a smattering of science. This form of "technical education" goes no further in 99 cases out of 100, and is, for all practical purposes, valueless.

In our colleges, where we might expect to find students ready and eager to specialise, we find either the facilities lacking, or the students apathetic. Not one college or university in this country possesses a special professor of electro-chemistry or electro-metallurgy, or such a laboratory as that at Aachen—their funds do not permit of such necessary additions. Would not portion of the above £800,000 per annum be usefully employed in providing these?

Our students, as shown by the fate of the proposed course of lectures at University College, are also unready to avail themselves even of the limited opportunities for gaining knowledge of these new branches of science which are offered to them. They doubtless consider themselves much too occupied with the regular classes and work to wander in these by-ways of applied science. But these by-ways will not improbably become of great industrial importance in the future; and our college authorities and students will no doubt awake to a recognition of this, when serious injury to the interests of our country has resulted from their past neglect.

SECOND-HAND BOILERS.

The recent explosion at Barking occurred to a boiler which, though second-hand, proved to be sound and in good condition. Frequently it happens that the endeavour to secure economy from higher pressures causes really first-class boilers to be put out of use many years before they are worn out. We have seen boilers carrying 90 lbs. pressure thus rejected which were as fit for the pressure as the day they were put in, but they were removed to make room for boilers at still higher pressure. When a boiler is removed from its place, cleaned outside, well rubbed down, and clean painted, there is frequently nothing whatever to show that it is not absolutely a new boiler, and such boilers badly wasted inside have been sold on the mere word of the second-hand broker as good, and have ended in disaster. So far as the outside of a boiler is concerned, so long as there is no wasting along the lines of the longitudinal seating walls, or the cross walls, there will usually be no outside defects to be found. What there are will be trivial and will not be hard for an experienced inspector to discover. An inspector knows where to look for the probable defects. But where a boiler has been on a dry seating the serious defects will be visible inside, or in the furnace. No boiler should be purchased until its furnace fittings and all brickwork have been entirely removed, and every particle of dust and dirt cleared away, and in no case ought a boiler to be purchased without an inspection by some capable engineer or inspector, preferably of experience in boiler inspection.

A boiler may look perfect inside and out, and yet it may be badly grooved, or, rather, seriously grooved, at the furnace angle irons. Such grooving is sometimes plainly visible; at other times it consists of little more than a line, hardly noticeable to the inexperienced eye, and yet extending deeply into the corner of the angle iron, and likely to demand extensive repairs. A very casual glance at the interior of a boiler is sufficient to show if there has been corrosive action going on, and whether, if any, it has been stopped, or is still active. But the faults, such as grooving, which are more or less a consequence of defective construction, occur quite irrespective of the quality of water, though they may be intensified by bad water. No second-hand boiler is better for being second-hand, though many are better than other makers' new boilers.

In judging of a second-hand boiler the maker's name may be taken as some evidence of original quality, but purchasers should be careful to know that the name plate has not been placed on an inferior make of boiler. Here, again, experience is a good guide. There will be features in a boiler of 1870, for example, which would not tally with a dated name plate of 1890. The public safety demands that, for the purposes of trade gain, no boiler breaker ought to be allowed to buy and sell second-hand boilers in a promiscuous manner. Probably the majority of these second-hand dealers are quite ignorant of the safe stresses in their goods. Others again care nothing so long as they can effect a sale. We have seen a yard full of the semi-portable class of agricultural boilers offered for sale at various prices from £20 to £100, some of which were wholly unfit to be worked at all. Yet apparently there is nothing to prevent an unsafe boiler being sold to any back street workshop where it will be badly cared for and worked at an excessive pressure.

In the above-named yard we fully believe that the owners were perfectly able to judge the fitness of a boiler to work, yet so far as we could see they relied entirely upon the maxim, *caveat emptor*, and gave no hint whatever as to the safety of members of their stock. In a case last year where a broker had sold an unsafe boiler, the Board of Trade Commissioner who had to investigate the explosion of the same, stated that the case was one of the worst which had come before him, and a heavy fine was imposed on the seller. It seems only right that when men elect to deal in such things as steam boilers they should be competent correctly to judge as to their safety, or should employ some competent person to give them the necessary assurance. We believe some brokers do obtain the opinion of a boiler insurance company, but there is more or less risk in this, especially where boilers are so much alike, that even with a dimensioned sketch they cannot always be identified. An unscrupulous broker can transfer a report on one boiler to another one. It is wise to insist that what an insurance company is reported to have certified shall be so again certified when the boiler has been put in its final place of work, or it may be rejected.

There are so many places, especially on large contracts, where a second-hand boiler may legitimately be employed with perfect safety, that the trade in such articles must not be condemned. It is perfectly honest if fairly carried out, but proper restrictions may reasonably be demanded to secure public safety. We believe that a powerful factor in securing safety would be the registration of every steam boiler. This could be best effected probably through the local authorities. The information to be thus secured should be—type, length, diameter, maker, working pressure, age, and, if insured, and by whom. The register could be made very compact by using letters to denote types and makers and insurers, and, if published, would be largely purchased, and would most certainly bring upon every boiler user the attentions of at least some of the boiler insurance companies. The fact of being thus called upon would awake some sense of responsibility in the user.

ELECTRIC LIGHTING AND REFUSE DESTRUCTION IN ST. PANCRAS.

Some practical steps are now being taken with a view to the utilisation of the waste gases from the St. Pancras refuse destructor, to which reference was made in these columns a fortnight ago. At the last meeting of the Vestry, Dr. Walter Smith, in moving the adoption of the report of the Electricity Committee, said that the Committee were very anxious to assist the destructor if they could, and if there was anything to be got out of it they would only be too pleased. The Committee reported having had under consideration the question of fixing at the destructor the Babcock & Wilcox boilers removed from the Regent's Park station, and had received a report by Mr. S. W. Baynes, chief electrical engineer, in connection with the matter. On the recommendation of the Committee it was decided to adopt the suggestions made by the engineer and to give special directions for the observance of the conditions mentioned in his report in regard to the firing of the destructor furnaces.

The Engineer's Report.

In the course of his report Mr. Baynes says:—"The plans show the [two] boilers on the east side of the six south cells, and arrangements have been made so that they can be fired from our stoke hole when necessity arises. The face of the boilers will come almost lineable with the existing steam generating plant and level with our stoke hole floor, and in this position they will be under the surveillance of our own stokers, thus avoiding the employment of additional hands. Every care has been taken to make ample provision for the removal of the large quantities of dust which will be deposited in the flues and on the heating surface of the boilers, so that this can be removed with the least possible inconvenience and expense. I estimate the cost of fixing these two boilers, including steam pipes and all necessary accessories complete, will be about £300 (three hundred pounds). With regard to the third boiler, this will be most advantageously placed at the south end of the east cells, intercepting the gases in the down taken *en route* to the chimney, but I would advise the committee to defer the placing of this boiler until we have had an opportunity of ascertaining the practicability of utilising the heat from the cells as they are now running with the structural improvements which have been introduced.

"It would have been preferable to have placed the boilers in between the destructor cells, somewhat similar to the methods employed elsewhere, but with certain improvements and modifications. I have considered the matter very fully from this standpoint, but find same to be quite prohibitive, having regard to the structural alterations necessary, and besides the fact that we should have to demolish three or four of the destructor cells to accommodate the boilers. Now, as to the possibilities of obtaining good results, I wish particularly to lay stress upon the importance of avoiding the free admission of cold air into the flues. A large quantity of air is often admitted when feeding the furnaces from the hoppers. It is also of the utmost importance that the bars should be kept well covered with refuse, and that the trimming operations should be executed with the minimum of delay. Too much importance cannot be attached to these details. I have made an inspection of the furnaces, and find that the doors in several instances are badly bulged and a bad fit. These should always be kept in good order, otherwise the permanent admission of cold air will have a deleterious effect on the results. When it is borne in mind that a bare place as large as one's hand on the fire bars (in the case of a steam boiler) is sufficient to almost entirely arrest the generation of steam, it will be readily comprehended that the necessity for strict attention in regard to these details cannot be over-estimated."

SOME GENERAL OBSERVATIONS ON ELECTRIC TRACTION.

By HORACE F. PARSHALL, M.I.C.E., M.I.E.E.

(*Continued from page* 154.)

Mr. Baylor said that the discussion had run in one line of conduit *v.* overhead systems, and his remarks would follow in that direction. There was no doubt that the question was a difficult one to speak definitely upon, especially in corporation work, where in any case first cost was not taken so much into consideration, for the reasons that corporations could borrow money very freely, and at a low rate of interest. He found, however, that the feeling in Manchester was not to that effect, and that the question of first cost was a very serious item. The figures which Mr. Clirehugh mentioned on that subject for the conduit, trolley, surface contact, accumulator, &c., varied over a very wide range. However, he thought there was no system had a range so great as the conduit system. Alderman Higginbottom had given them a figure of £10,000 or £11,000 per mile for the conduit system, and pointed out the enormous expenditure if they adopted that system as compared with the trolley system. £10,000 or £11,000 would instal in Manchester a very inferior conduit system. The only examples they had to look at for conduit construction was in Washington and in New York. Washington was hardly a case for comparison, as it was not a commercial city in any sense; the climate was different, and the whole atmosphere of the place was non-commercial. In New York the comparison was closer. Some years ago cable systems were laid in New York, and the conduit system was adopted largely for the reason that the Metropolitan Company made contracts involving the installation of a system which should not interfere with the existing conduit as laid down, and if the electric experiment was unsatisfactory, the conductors had to be removed, and the cable replaced to operate the cars. It was not unsatisfactory, and that was largely, if not solely, due to the fact that the conduit was large in size. He thought the failure of the Bentley-Knight system and other systems in the early days was due to the fact that the conduits were not large enough. The conduit system was merely an overhead system turned upside down. But what they had to do was to make the sewers in the street big enough to drain the conduit, and, further, to properly insulate the conductors in the conduit. Under those circumstances there was no reason why the conduit system should not work in any climate. If they took New York as a basis for figures, they were perhaps getting themselves in trouble, for the reason that in New York and in the North and North-Easterly American cities the pipe systems were, as a rule, far enough below the ground, and would allow free excavation to conduct a reliable conduit. In Manchester, however, and perhaps generally in England, he thought the pipe systems were considerably nearer the surface of the street. They had to excavate into the ground 3 or 4 feet to construct the conduit system, and the removal of those obstructions involved an expenditure which could not be calculated, and if a sum of £11,000 or £15,000, or any number of thousands of pounds were taken as a basis for calculation, there was no safety in it; no one could possibly calculate what was going to be done after they had opened the streets. It seemed to him that the wisest course for Manchester to follow would be to adopt the overhead system, making the expenditure in the first place a minimum, and having a system which had been tried in 99 cases out of 100, and which had proved satisfactory, and then if the conduit system developed in later years, it could be adopted. He thought the chances of improvement on the single conduit construction of to-day were very slight. It was an unfortunate thing for the trolley system that in the early days of electric traction that system was laid down in many cases on essentially cheap lines, and a great many lines were put up which were unsightly, and a reputation for being unsightly had clung to it ever since. There was no reason why the trolley system should be made unsightly, even at the same time making it inexpensive. Dr. Hopkinson referred to accumulator traction, and he thought there was a great deal in many of the remarks which Dr. Hopkinson made. It was a fact that accumulator traction had not been found successful as a system, but only in conjunction with a trolley system, and then under compulsion, and perhaps it would be going rather too far for him to say that the Corporation of Manchester and other corporations in England should show the wisdom of their conservatism in waiting for the world at large to develop electric traction, and at the present time by following the lines of standard practices which had proved the world over to be satisfactory.

Mr. A. B. Mountain said he thought there was a point in the paper which they wanted to look at very carefully, that was the question of return currents through the earth. Mr. Parshall had put that very clearly in his paper, and he thought that when selecting any system they must not forget that those return currents were going to cause considerable trouble to pipes, &c., and he thought that that point wanted very seriously weighing when deciding the system to be used. If they put two wires overhead or underground in such a way as to do away with those return currents, to his mind they would have done a good thing. There was one other point in the paper which he did not quite understand, viz., what where the great advantages of three-phase over single-phase? He had been getting a few facts, and he could not find that there was very much in it. He may have been to the wrong place to get the facts, but taking efficiency and power factor there was very little in it. He did not quite see that the advantage of putting down a three-phase plant would be worth the extra expense. He was taking, of course, the fact that many corporations were already established with single-phase. Another point in connection with three-phase work was the question of cables. The copper was reduced, that was perfectly true, but those who had to buy high pressure cables knew perfectly well that the quantity of copper in their cable did not represent the price altogether; the insulating material on high pressure cables came to a pretty high figure, and he thought everything would be very evenly balanced by the extra insulation of the cables. There was another point in connection with accumulators, Mr. Parshall spoke of the fly-wheel question which has been going on. He could not help thinking that accumulators, if used in conjunction with sub-stations, were going to take a great deal of the shock from the system.

Mr. Hans Renold said he approached that subject like Alderman Higginbottom, as a mechanical engineer, although as such he had been connected since 1883 with Mr. Holroyd Smith at Blackpool, and he had since then been connected with about 20 different undertakings of electric traction, so that it was a subject that he was not altogether unacquainted with. Mr. Higginbottom had stated in his first speech, and again to-night, such statements as would not go down his throat, in fact, that evening, he, Alderman Higginbottom, had gone upon the same lines, as for example, he stated that the rails as laid down at present would not do for the conduit system. Now, he had made careful investigations in New York and different towns in America, and his experience went to show that the rails that they had in Manchester would do very well, although they were not as heavy as those which they were putting in at New York or Washington. They put heavier rails in not because it was required for the conduit system, but to make a more permanent job of it, and to give their public smoother riding and more comfort with their conduit system than could be got with the trolley system, because with the trolley system they usually tried to make it a cheap affair. Some mention had been made as to the cost in New York; it was no use talking about figures when one compared the two systems. There was very little known as to what one system exactly cost, and perhaps nothing as to what the conduit system cost. They had practically only New York, the 62 miles of the Metropolitan Company, and Washington in America, and Berlin and Buda-Pesth on the Continent, and the figures obtained in New York were no guide whatever as to what could be done here in Manchester. Circumstances were very different, and the figures he referred to were those which Alderman Higginbottom gave in his first speech to the Council. He thought they were not quite fair, and the systems could not be compared by putting the cost of one against the other. They were entirely two different systems. With regard to the fear of another system coming forward in the near future that would supplant anything that they had done to-day, as an accumulator system, or any other system, he could only say that he thought the system of conduit in New York was so simple, so mechanical, that he did not know where improvement could come from, except improving the switches or insulators. In the main that was the system, and it was no use looking forward for improvements, as it was about as complete as they could look forward to anything. One could not stand at a street corner in New York and look at those Metropolitan cars running without noticing how easy, how smoothly, and silently those cars ran, with no sparking at all, and they had no lines overhead. Then if they went over to Brooklyn and New Jersey they would see the overhead wires, those enormous obstructions in the streets, and they would see the sparks flying from the overhead wires and the sparking at the wheels. All that was extremely trying, and his feeling was that if something better could be had it ought to be had. Of course, he was quite aware, as Alderman Higginbottom had stated, that electric traction could be divided into three parts, the installation of the station, of the car, and of the rolling stock. He had not got all the facts with him, but one could not look at the question from a mechanical point of view without finding that the conduit system was considerably superior to the overhead system, moreover, he heard there was considerable leak from the rails as a return in the overhead system. Commercially he thought they could not compare the two systems, they were so unlike, and the conduit system had such advantages over the overhead system. They could work very much heavier traffic with it, and it required very much less power. There was less sparking and no leakage. He was not prepared to go into the electrical details, as he had already stated that he looked at the point from a mechanical engineering point of view, and as a citizen of Manchester, but there was no doubt in his mind that this elec-

trical traction in the city was as much a mechanical question as it was an electrical one, and from a mechanical point of view there was not the slightest doubt about it that the conduit system was the system.

Mr. R. W. Blackwell said there were two points upon which he would like to lay additional stress in the paper; one was the limitation that Mr. Parshall suggested as the proper one. It was scarcely possible that a direct current system could utilise more than 5,000 kilowatts; the other, that when you are putting in an electric power station put one in large enough at the beginning. He presumed that the reason that the chairman had called him from obscurity was the mention of Bentley-Knight system. He had had the pleasure of being the chairman of that company. In 1883 they were running electric cars, but till 1887 he devoted most of his time to the conduit system. Mr. Holroyd Smith was at the same time doing extremely good work at Blackpool. The results were practically the same. He then went into the overhead system and had been there since. So far as he was able to diagnose the situation, the question of the difference between the conduit system and the overhead system depended upon the amount they were prepared to pay for the æsthetic luxury. He could only suggest that if the city of Manchester saw fit to go in for the æsthetic adornment of this city they should devote the £300,000 or £400,000 to the purpose of some great public work. So far as he was able to see, and he had been practically connected with traction since 1883, there had been no change in the conduit since that time. The construction was the same as Mr. Holroyd Smith's construction at Blackpool, the construction of the Bentley-Knight Company in the old days, and the construction was put in to-day by the same men that put it in in the old days. What they had done was to increase the dimension of the parts, to increase their cost and solidity, to make it a more immovable part of the city structure. Unless the rails already laid were taken up and supported together with the construction of the conduit they would not do. That would run them to an expenditure which was very heavy, and it would cost at least £10,000 to £20,000 per mile to put down a system that would run and work well. In the old system they did not key the rails to the construction of the conduit, and consequently they had frequent breakdowns.

Mr. Slater Lewis said, personally speaking, he could not agree that it was entirely an electrical question or a mechanical question. Mr. Hans Renold looked at the matter from a mechanical point of view, and if they would allow him for a moment, he would explain what had happened in New York from that point of view, though he thought Mr. Parshall had been left out in the cold, as the discussion had not been confined to his paper. He referred to a breakdown through the snow in New York in November. On that occasion it did not get into the conduit. Last week, however, there was an entire breakdown of the system in consequence of the snow drifting into the conduit. He was afraid Mr. Hans Renold had been to New York at the wrong time of the year; he (Mr. Lewis) had been there for some months and had not found it necessary to use an umbrella on a single occasion, but in Manchester he had not been without one for the last two months. The whole thing was a matter of insulation. In Manchester there would be a large deposit of dirt and filth of every description if they adopted the conduit system. The atmosphere was also very damp. His friend, Mr. Doherty, would tell them that glass insulators for telegraphic purposes were an absolute impossibility in England, owing to the damp climate, whereas, in America nothing but glass insulators were used. He would like a conduit system, and from the æsthetic point of view it would be the right one, but in view of the fact that there was an air-tight and a water-tight system of conduit in successful operation on a small scale in America, it would be unwise to spend three-quarters of a million of money in putting down a system which might be of no use, practically, in a couple of years' time. With regard to Mr. Parshall's paper, he agreed with Mr. Mountain, that a direct current system would be advantageous for many reasons, and he could not altogether go with Mr. Parshall as to the use of heavy fly-wheels on the engines, as he could not see how the heavy fly-wheel would be of much advantage where a three-phase system was used, because the power taken by the cars had first to pass through a rotary converter. The shock would, therefore, be upon the rotary converter and not on the engines. As he took it, if they overloaded those rotatory converters, something like 20 or 30 per cent., they would get out of phase, and they had to shut down and start again. We had been told recently that a 50 B.H.P. rotary converter made by Messrs. Brown, Boverie & Co., pulled up with a load of 65 B.H.P., and he could not help thinking in consequence that rotary converters in the city of Manchester would have to be abnormally large to get the loads over the peak. He was sorry so much time had been taken up on the overhead *v.* conduit system question, as he would have been very pleased to have heard the views of many gentlemen present on Mr. Parshall's paper.

Mr. C. H. Wordingham said the discussion had unfortunately, to his mind, drifted into a discussion of overhead *v.* underground. Although he objected to that on principle, he was going to discuss it himself. Undoubtedly it was a question of burning interest locally, if not to engineers in general. He very much questioned whether there was very much to discuss in the matter. He himself was a convert, or as Mr. Hans Renold would say, a pervert to overhead as against underground. When the question of electric tramways was first raised, he thought that the Board of Trade regulations were such as to practically prohibit anything except an insulated return, and with so large a system as they had in Manchester, that would have been the case. Largely in consequence of this he was led to advise the Corporation to adopt the system of multiphase generation with numerous sub-stations; those sub-stations would not be in most cases more than a mile apart, consequently the most distant point on the earth return would be half a mile from the sub-station. With four lines of rails they could keep the drop very low. He did not propose to trouble them with any description of the system which they were about to adopt in Manchester, suffice it to say that to him that paper had been very gratifying, because in every point it backed up and bore out the very system which he had advocated, and which he had advised the Corporation to adopt, and which they had decided to adopt. With regard to the controversy on overhead and underground systems, it appeared to him that the fact was lost sight of that the determining factors were not engineering considerations. He for one did not for a moment deny that the underground conduit system was perfectly practicable; it might be everything that was desirable as Mr. Hans Renold appeared to think, but the considerations which determined the system that they were going to adopt in Manchester were really political considerations; he used the word political in its proper sense. Those matters had been so ably dealt with by Alderman Higginbottom that it was unnecessary to enlarge upon them. There was no doubt in his mind that at some future time there might be some better system than the overhead trolley, but what he did say was that at the present time under existing conditions, having regard not only to engineering considerations, but to questions of policy, the only possible system was the overhead trolley. There were one or two points in Mr. Renold's remarks he would like to refer to. In speaking of the rails he rather implied that different rails would be required for the underground and overhead system. Nothing of the kind was required. The point was that they already had those heavy rails laid down, and if they put down a conduit system, they would have to wipe out the cost of laying those rails. The cost of the rails was by no means the whole of the cost of providing tram rails. The greater part was in the laying of the rails. He thought Mr. Hans Renold rather weakened his case by a few of his remarks. Mr. Renold referred to the smooth running of the cars, and the sparking. No one could doubt that the cars would run just as smoothly whether they were supplied with current from above or below, and there might be just as much sparking with the underground system, though one could not see it. Mr. Renold further remarked that a point against the laying of the overhead trolley system was that the leakage was in some way costly. As a matter of fact the leakage was by no means waste, it simply saved them in the cost of conductors. It merely meant that the leakage took place from the earth into the water pipes, and provided that the Water Company did not object to the use of their pipes for a portion of the return, he did not see that they need care. Of course, actually, they would avoid such leakage. He would like to refer to Dr. Hopkinson's remarks respecting accumulator cars. Accumulators were very attractive things in many respects, and in the modified system in use at Hanover they might work well if, and it was a big "if," they could determine the conditions of maintenance. He thought there was great difficulty as regards the maintenance of accumulators. There were a great many points raised in the paper. The author referred to multiphase generation and rotatory converters. Mr. Mountain raised the question of multiphase *v.* single-phase. From the point of view of rotatory converters, he did not think there could be any doubt that multiphase was preferable. They had in that system a steady flow of energy, as steady a flow almost as they had with continuous current, and experience went to show that rotatory converters worked very much better with multiphase than with single-phase currents. He must next refer to the question of the heavy fly-wheel. He thought the question of shocks to the plant had been rather over-estimated, but it was vitally important that they should design plant so that they could get an even turning moment, as if they did not they would get surgings and the converters would get out of step.

Mr. Parshall, in his reply, said he felt gratified that the discussion had been so extended; in fact, it was a better discussion than was common to most institutions.

Mr. Clirehugh had remarked that the conditions set down in the paper had practically limited engines for driving 1,500 kw. dynamos for electric traction to the Corliss type. He had examined his paper again, but could not see that this was the case; in fact, he knew of engines other than that of the Corliss type driving 1,500 kw. dynamos. Mr. Clirehugh was quite right in stating that my experience with 1,500 kw. machines for traction purposes was limited to the United States. I have yet to meet an engineer whose experience with this size of engine is not limited to the United States, since so large a machine is not at the present moment in use elsewhere. Mr. Clirehugh doubted whether the method of bye-pass and steam piping, which I am using in Dublin, was original. He could not say that it is, although he had never seen a system designed like the Dublin system. He was not sure whether Mr. Clirehugh was in a position to say whether or not the system of piping is original, since the plans illustrating the system mentioned had not yet been exhibited by the Society.

Mr. Mountain stated that he had gathered a few facts respecting multiphase currents. Certainly, if Mr. Mountain had gone into the matter very deeply, he would know that single-phase currents cannot be commutated except in small machines, and that this is the primary consideration in using multiphase currents for transmission when distribution was to be effected by continuous currents. Mr. Mountain's remarks imply that the saving of copper in power transmission was of little importance, since the cost of copper in a cable was small as compared with the total cost. Probably, Mr. Mountain had in mind very small conductors, since in large conductors the cost of the cable varied approximately with the cross section of the copper therein.

Another speaker alluded to the liability of rotary converters to fall out of phase when over-loaded. This is not the case in properly designed installations, as was found by testing large rotary converters, which was found to stand 100 per cent. over-loading without showing any tendency to fall out of phase. In fact, the rotary converter properly installed was the most suitable and safe of all machines under all loads.

Mr. Wordingham spoke of fly-wheels on engines when used with

rotary converters, to fulfil the conditions set down in the paper as to phase displacement owing to irregular angular velocity, a very heavy fly-wheel is necessary, much heavier than to fulfil the mechanical conditions for good regulation and proper cylinder capacity as outlined in the beginning of the paper. Mr. Wordingham seemed to think these shocks to traction engines had been over estimated. In his opinion they had not. He had to reply upon his own experience in this matter, since he had seen engine after engine fail that had been designed with satisfactory results for nearly every class of work except traction work, and all experience gained so far tends to build engines for traction work heavier in all essential parts.

The discussion had turned largely on the comparative fitness of the overhead trolley system and the conduit system. This was more of a commercial than an engineering question, since there was no doubt that either system can be made to work satisfactorily. As pointed out in the paper, the objections which are generally urged against the overhead system are not of a very substantial character. There are disadvantages of a somewhat similar character in connection with the use of the conduit system, namely, the additional rails run through the street.

It might be inferred from the remarks of some of the speakers that the cost of the conduit system is not known. All of the elements of cost inherent to the conduit system pure and simple, are known and easily determined. The cost, however, of dealing with obstructions, such as gas and water pipes, draining the conduits, and the cost of making provision for accommodating the traffic while the streets are blocked by the progress of the conduit work, cannot be determined in advance. In the average case he would say that the conduit system properly constructed for such a city as Manchester, would cost about £12,000 more per single mile of track than a mile of the overhead system. No practical advantage will be obtained, however. If, however, the people at Manchester are able and willing to pay this price for getting rid of the overhead trolley, he must congratulate them on being in a very satisfactory financial position.

SOME QUESTIONS re MUNICIPAL ELECTRICAL TRADING.

The following interesting letter from the pen of Dr. J. A. Fleming appeared in Tuesday's *Times*. It possesses a special interest for the electrical trade at the present moment, as it brings forward many a point which must necessarily arise in connection with this important controversy—a controversy which promises to be very prolonged and intricate:—

I trust that the suggestions of Major Flood Page on the subject of municipal trading will not be allowed to pass without practical action of some kind being taken upon them. On the general question of the legitimate limits of municipal trading I will not venture to express an opinion, but having been for the last 18 years somewhat closely connected with electrical manufacture and enterprise, I should like to point out one or two facts connected with the industrial utilisation of electricity which have a bearing on the matter at issue. It appears that some 70 municipalities desire to engage in the manufacture of dynamos, electric lamps, and electric appliances, and to acquire or purchase patent rights over the same. It must not be forgotten that in the continuous flow of electrical invention, each improvement as it arrives is the subject of patent protection. At the present time some 5,000 or 6,000 electrical patents are taken out per annum in Great Britain alone. Hence no municipality can advance very far in electrical manufacture without either infringing or acquiring particular patent rights. These, however, have a very problematical value until tested in the Courts, and every one of the great electrical inventions of the last 20 years has been the subject of long, costly, and hazardous litigation between manufacturers. Corporations, therefore, which enter the arena as electrical manufacturers will certainly have to be prepared to speculate in or defend patents at the expense of the ratepayer. The next question which arises is as to the range of manufacture. Is it proposed that municipalities shall manufacture merely for self-consumption, or supply other towns as well? Is one town, for instance, to establish a manufactory of electric lamps for its own citizens only, or to supply outsiders in addition? It is a simple truism to state that the cost of production depends on the scale of manufacture, and that a municipality producing on a small scale has not a shadow of a chance of doing it as cheaply as large and experienced manufacturers having a far greater output. Moreover, it must be remembered that in embarking on electro-technical manufacture a municipality would have to bear the loss of all failures and costly experiments. Under a system of purchase by contract and specification the ratepayers are protected from serious risks in the purchase of such expensive articles as dynamos and engines, but municipal trading would deprive them of safeguards for efficiency without any necessary corresponding advantages. Also it is obvious that highly technical manufacture cannot be conducted by any body of men merely in the light of nature. Hence a municipal committee placed in control over some specialised scientific branch of production would not improbably have to learn its business at the cost of expensive blunders, for which the ratepayers would have to pay. In fact, the ratepayers would become the involuntary shareholders in a practically unlimited liability company, the constantly-changing directors over the same depending very much for guidance on their own officials. The strongest argument of all, however, against municipal trading is that it would destroy the stimulus to continual invention and improvement which springs from the incessant rivalry due to free and open competition. The private manufacturing firm which does not advance with the times dies. The manufacturing municipality would probably find its greatest safety in going slow. The point which should be emphasised at the present moment is that the risks and speculations of manufacturing enterprise constitute an absolutely different class of undertaking from the urban supply of gas, water, and electric current, or even telephone and tramway facilities. These may perhaps all be most advantageously managed by the representatives of ratepayers in the common interest, but corporations have less justification for undertaking the risks of electro-technical manufacture than they have for conducting the municipal supply of milk or meat.

APPLICATION OF THE ELECTRIC MOTOR TO WARSHIPS.

(*Concluded from page* 169.)

So far we have dealt only with the actual machines, but the electric system stands out pre-eminent for the transmission and manipulation of the power. The great weakness of the hydraulic system lies in the mass of piping, valves and rods; the turret must contain an intricate network of these, and though the duplication of this system mitigates the chance of failure, it greatly increases the complication, until when an auxiliary system is thrown in, the result is a mass of piping and valves which require a considerable knowledge to work. In like manner in connecting the forward and after systems to give more strings to the bow, we have long lengths of pressure and exhaust piping traversing the intermediate compartments.

The advantages of electric wires are very clear; the hydraulic pipe occupying considerable space must more or less rigidly pursue its course throughout the ship—the electric wire is capable of infinite contortion and adaptability.

Duplication is equally possible with an electric system. A burst or severed hydraulic pipe means a temporary loss of power until the valves leading to the fault can be closed. A severed main would correct itself on the duplicate. An earthed main would be harmless. An earthed main and return would blow the fuse, the duplicate remaining intact.

It is claimed for the hydraulic system that with a burst pipe the location of the fault is at once known. A damaged main could be made equally evident. Moreover, and above all, the latter is repairable in action, where the injury to the pipe cannot possibly be remedied within reasonable time.

Lead casing has conquered the difficulty of insulation, and the electric wire will outlast the ship into which it is placed; practically little or no care for maintenance would be necessary outside the machine terminals.

Another great drawback to the hydraulic system is the multiplicity of rods and gearing necessary to connect the valves to the levers in the sighting positions.

Here, again, the electric system, where switches could be placed in any desired position, would have an enormous advantage.

Flexible leads again would be a vast improvement on the elbows and pivots by which hydraulic pressure is led into moving compartments.

In the late war the Americans had to contend with great heat, the other extremity has to be considered in hydraulic installations, and elaborate heating arrangements provided to prevent cracked cylinders and pipes in cold weather—an entirely unnecessary precaution if electricity were employed. Space does not permit one to enlarge on the above points or to mention minor ones where electricity is equally at an advantage.

Enough has been said, it is hoped, to show that in not receiving fair trial electricity is suffering unmerited neglect, and that if foreigners are before us in accustoming themselves to its advantages we have only ourselves to blame.

Apart from the gun working machinery, in continuing to

use steam for our remaining auxiliary engines we are perpetuating a still more glaring error. There are, however, at last signs of yielding in this direction, the value of the electric fan is so clearly apparent that it is now being adopted even in our own ships, and electric capstans are likely to be installed in the not too dim future.

A few general remarks will best point out the faults of the present system.

The engines being so numerous and situated in all parts of the ship, an intricate system of steam pipes is necessary, and in few cases can these be led direct to their work; they must be bent and worked in to clear obstruction and spaces in the compartments through which they pass.

The constant changes of temperature, causing irregular expansion, render the steam joints extremely difficult to keep in order. This in time of peace may be merely an inconvenience, but in consideration of the effects on men working in the various compartments, in time of action it assumes a much more serious aspect.

A compartment with a bad steam leak very soon becomes untenable unless well ventilated; thus, again, this reacts on the ventilating system, often turning it from a convenience to a necessity.

Numerous causes might derange this system in action; the possible consequences of the prime cause, the leaking steam pipe, are therefore alarmingly serious. In hot climates, the temperature of compartments containing steam engines may well be compared to our anticipation of a nether region —a fact clearly and continuously pointed out by our American cousins since the war.

The disadvantage of the size of steam and exhaust pipes is not alone felt in the space occupied, but also in the size of the holes they make in watertight bulkheads.

Steam engines used for such work as capstans and winches are highly uneconomical in character, as no expansion of steam takes place in the cylinders.

Where steam engines are necessarily exposed, such as ash hoists, boat hoists, winches, &c., they would probably be destroyed in action, where an electric motor of the armoured type would stand a far better chance of survival.

Although the chance of steam pipes being severed by gun fire is small, in that chance lies catastrophe. But it is unnecessary to multiply further such numerous defects and equally unnecessary to point out how infinitely more suitable electricity must prove for such transmission of power.

The most extensive use of electricity would involve nothing but the use of well tried machinery, and with such advantages in view the principle obstacle to its adoption can only be an unnatural ignorance of its power.

Students of naval matters, who at the same time possess an adequate scientific knowledge of various forms of power transmission, are rare. Naval constructors lack that most necessary experience of sea-going conditions.

Naval engineers and executive officers, though highly capable, are as a whole lamentably ignorant of alternative methods not brought under their immediate notice, and it cannot be denied that many practical naval officers have a distrust of all things electrical. The reason is not far to seek; in the first place electricity is mysterious and therefore distrustful; secondly, they have experience of the struggling days of incandescent lighting, telephones, bells, &c., and many impossibly delicate electrical instruments to which their lordships have from time to time given trial; they remember failures, but are entirely ignorant of the causes, so that to them they failed because electrical.

Those who have a knowledge of matters nautical, and who follow the commercial development of scientific invention, must clearly see that as strides are made in mechanical progress on shore, an adaptation to naval conditions is always possible and as clearly they must see how inclined we are to lag behind from over-caution, or, perhaps, over-confidence.

Electrical development on shore has advanced by leaps and bounds, an example which in our navy has been treated with almost criminal negligence.

The naval administrative machinery, in this connection, is complicated, and it is difficult to place the responsibility in any one particular direction. Subject to the First Lord, the actual head of all constructive and engineering matters, is the Naval Controller, an admiral whose enormous business responsibilities are little appreciated by the general public.

The heads of departments immediately below are the Chief Constructor and Engineer-in-Chief whose duties are apparent.

All questions of armament are largely decided by the department of the Director of Naval Ordnance, which contains distinguished naval officers of large technical experience.

There is, further, a gentleman holding the position of Admiralty Electrician, who is very severely criticised by naval officers. As, however, nearly everything electrical in the navy is behind the times it would appear more likely that this official's power is unduly limited, since it can scarcely be supposed that he has not himself kept pace with modern improvements. Possibly, therefore, he is much maligned. Apart from the Admiralty, the naval executive officers have two sources of technical scientific education headed respectively by the establishments *Excellent* and *Vernon*.

The former deals with guns and all that pertains thereto, the latter and smaller with torpedoes and matters electrical. A certain number of expert officers are annually turned out by both and drafted to sea-going ships to perform the special duties connected with their training. The talent of young officers is attracted to these expert lines, and naturally in the hands of the schools lies power for push and innovation.

A divergence of opinion and a friendly rivalry, more or less natural, exists between the schools on points where interests merge. Incidentally, but importantly to this article, some such divergence exists with regard to its subject. The larger school looks upon hydraulics as its well-nutured child, whereas the smaller, naturally adopting electricity, regards its infant, the electric motor, with some affection, and a very sorry infant it is, unfortunately.

Speaking generally, as with the executive officer lies the direction of machines, the care and maintenance is in the charge of the engineer, who, unfortunately, is singularly deficient in electrical knowledge. Some slight theoretic acquaintance of the subject may come in his college course, but no practical experience, till he is placed in charge of a dynamo at sea, and then, as he does not interfere with anything outside its terminals, his opportunities are limited.

The question of charge is a rock on which many subjects split, and around which much jealousy surges. Narrow it may be, but there is much human nature in the fear that new developments will pass into our neighbour's hands, and our relative importance be readjusted accordingly.

The solution is easy if we pause to think.

The necessary training must inevitably follow constructive advance, and with the advent of electricity, naval engineers will be converted from purely mechanical to electrical engineers, competent and fit to take charge of electrical machinery as they now do of hydraulics.

True, such training should come at once, but unfortunately provision is not a strong point of the naval system.

This slight review of the administrative powers is necessarily brief and incomplete, but it endeavours to show the nature and training of the men under whose consideration electricity is forcing its way to the front, and the circumstantial facts which surround it in the naval service.

Electrical training is in fact entirely confined to the small number of experts produced by the *Vernon*, the electrical mechanics of our dockyards, and that anomalous gentleman, the Admiralty Electrician, and these few are tied and bound in a manner precluding their employment of a knowledge of better things.

But a strong factor is this dilatory policy, perhaps the strongest, lies in an entirely different field; the contracts for hydraulic and other auxiliary machinery lie in the hands of a limited number of firms. It is obviously to their advantage to discourage rival forms of machinery for which they have never laid themselves out and which would throw much of their plant into disuse.

Through these many obstacles electricity has forced its way to find itself cribbed, cabined, and confined. As we stand at present, some few ships possess a limited number of electric fans, a very few of the larger cruisers work their big guns by its means. Three battleships have electric ammunition hoists for their large guns, and the *Majestic* class have an utterly inadequate electric auxiliary system for working their 46 tonners.

Space does not permit one to dwell on the details of these fittings. All are starved for want of power. Control

switches, safety arrangements, and all such devices are full of bad design and worse workmanship. Reducing gear is cogged and raises an unearthly noise—unnecessary rods are retained. In fact, the whole enterprise bears the impression that it was never meant to succeed. It is argued that it is only intended for trial. Can any reasonable being maintain that a fair trial could result from such an attempt.

Thus we grind on ourselves, let us turn our eyes abroad.

As early as 1894, French designers were inclining in favour of electricity in preference to hydraulics with a result that out of their very efficient Mediterranean squadron of six ships, one half place total reliance on this form of power for their gun working machinery. The highly admired armoured cruiser *Latouche Treville* was completed in 1894 with this motive power for all guns, and others of this type, including the *Pothau* present at our Jubilee Review, are also so fitted. Since then the pendulum has swung still further and nearly all new ships are employing electricity for this purpose.

Of Germany it is only necessary to say that she has taken the complete step in the *Aegir*, her crack cruiser, whose auxiliary machinery is entirely controlled by electrical transmission. They have leapt to 120 volts where our ships still maintain their inefficient 80. The result satisfies expectation, want of power and minor defects were felt, but before care and attention, difficulties are melting away and Germany is boldly and successfully passing the transition stage, obtaining adequate designs and practical experience.

The same competition is resulting in the same decision in the new navy across the Atlantic.

American doings are always very freely discussed in the press, and reports on the working of electric motors during the war are published. They are uniformly favourable, though handicapped by the usual hostility.

The result is that the new battleships, *Maine*, *Missouri*, and *Ohio* are to be completely equipped with electric fans, steering gear, turret and smaller ammunition hoists, and in new cruisers electricity is to be used in an equal or greater extent.

There is, of course, a lusty opposition founded doubtless to some extent on our own slow progress, but electrical advance is in a healthy state, added to which, in the words of an American writer of experience: "Another advantage which electricity possesses here as everywhere else in the field of applied mechanics, is that young engineers are educated in the knowledge of how best to generate and apply the agent in a manner which has never been thought necessary in regard to the older forms of stored energy."

Alas! that the same cannot be said of English naval engineers. Abroad our rivals are taking decided steps in electrical application. What then are we doing at home?

We are engaged to build 16 new battleships and a very large number of cruisers, with the prospect that electricity will be used only, as heretofore, for the lighting, some isolated fans, and, perhaps, a few capstan engines. With these exceptions we shall remain saddled with the same incubus of steam and water pipes and ventilating shafts, and before us but little hope of naval progress in electrical education.

There is surely a large enough field for enterprise here, and the requirements are that interest should be taken by competent electricians in naval conditions, and that the merits of electrical wares should be pushed until acknowledgment is forced.

Naval engineers are ill prepared for this change. Officers who appreciate the situation are bound in with red tape. The electrical advisers to the Admiralty are unable, or unwilling to move. Large electrical firms state that the Admiralty are unapproachable; they, therefore, appear apathetic.

With the growing appreciation of the necessity of the maintenance of our sea power, an ever widening field is presented. Surely attempts should be made to push wares in such a market, and in such a cause.

For the ship of the future is bound to have her detached machinery controlled by electrical force. Under similar protection to the main engines will be an auxiliary room containing powerful generating plant, sending forth its connecting wires in all directions. Dry, cool compartments, greater protection, greater space, less weight, silent machinery, and a more immediate control of the power must be the inevitable results.

PAPERS BY M. A. BLONDEL.

M. A. Blondel has sent to us copies of four papers recently published by him, three in the *Comptes Rendus*, and one in the *Journal de Physique*.

A New Hysteresimeter.—In the first paper he describes an hysteresimeter, very similar in principle to the well-known workshop instrument of Prof. Ewing. In the Blondel instrument a small pile of stamped rings of the sheet-iron to be tested, similar in arrangement to a dynamo armature, is mounted on a vertical axis, freely pivoted and controlled by a helical spring. The pile is 55 mm. in diameter, and 4 mm. in height. Round this a permanent magnet is revolved by hand, and the angular deflection of the armature observed on a scale divided in radians. The observation is not made from a zero, but is the difference of the deflections obtained by revolving the magnet first in one direction and then in the other. We suppose the friction of the pivots, due to the attraction of the magnet, is too great to allow the system to zero properly. The hysteresis of the specimens is obtained from Steinmetz's formula, $\eta \cdot V \cdot B^{1\cdot6} = 2\pi C$, where η the hysteretic coefficient of the iron, V its volume, B the maximum induction, and C the torque produced on the moving system. C is said to be given by the relation $C = \gamma(\theta - \theta')$ where θ, θ' are the scale readings with the magnet rotated in opposite directions, and γ is the coefficient of torsion of the spring measured in ergs per radian. It seems that the relation should be $2C = \gamma(\theta - \theta')$, and that a 2 has been omitted. The value of γ is obtained from the period of oscillation of the pivoted system when loaded with a body of known moment of inertia. M. Blondel proposes to use the instrument in two ways, one in which the magnet is turned very slowly, and the hysteresis of the specimen in different directions observed; and another, when the magnet is turned rapidly, and the average value of the hysteresis in all azimuths obtained. The first method he terms a static method, the latter a dynamic method. The theory of the instrument given by M. Blondel depends on the assumption that C, the torque produced on the specimen, is independent of the speed of rotation. This is approximately correct, except at low speeds of rotation, when C would be smaller. The instrument should be useful, though not, of course, one of precision. It has attracted M. Blondel's attention to two points connected with such measurements. One is that the hysteresis of sheet-iron is commonly very different in different directions, and the other that the extent to which the hysteresis depends on annealing is very considerable.

The Electric Arc.—The second paper, extracted from the *Journal de Physique*, is the description of an attempt to settle the vexed question of the mode of conversion of energy in the electric arc, and exhibits the confusion of thought and language usual with writers on this interesting subject. The results of the experiments performed are interesting and valuable. M. Blondel inserted into the circuit of a continuous current arc lamp an interrupter or commutator driven by a motor which, at certain regular intervals, disconnected the carbons from the battery for a short time, and connected them to a galvanometer. This operation was performed 40 times a second, and the lamp was disconnected from the battery for about one-fifth of the total time. The galvanometer connection lasted for about $\frac{1}{600}$th of a second at each interruption. The lamp, during the operations, burnt perfectly steadily, and showed no sign of any interference. The lamp was then removed and replaced by a metallic resistance adjusted to give the same current as had previously been taken by the lamp, and the deflection of the galvanometer observed as before. In both cases the deflections were small, irregular, and of about the same values, and the experiments showed no difference in the behaviour of an arc and a metallic conductor. The currents passing through the galvanometer were sometimes in one direction and sometimes in the other. Putting the results in round numbers for convenience of statement, the maximum galvanometer deflection observed corresponded to a steady current of 40 micro-amperes, which would be due to a steady E.M.F. at the galvanometer terminals of ·16 volt. Since the galvanometer is connected to the carbons 40 times a second, and at each time for $\frac{1}{600}$th second, this indicates a difference of potential at the carbons of 2·4 volts, immediately after the interruption of the current. But this calculation is rendered

worthless by the extremely irregular character of the figures observed, which give no ground for believing in the existence of this E.M.F. Assuming, however, for the purpose of argument, that the observation can be employed for calculation, M. Blondel calculates the electrostatic capacity of the arc, on the hypothesis that the galvanometer deflection is due to the discharge of the arc, acting as a small condenser, charged to the potential difference of the arc, 20 volts, and discharged 40 times a second.

He obtains a figure, ·032 microfarad, by a method we do not at all understand. We have, however, made a calculation, and obtained a figure of the same order, as follows:—

The loss of charge of a condenser whose capacity is k, charged to a potential difference, v, and discharged for a time, t, through a resistance, r, is $k\,v\left(1-e^{-\frac{t}{kr}}\right)$. In this case the potential difference is 20 volts, the time is $\frac{1}{600}$th second, and the resistance is 4,000 ohms, and the same loss of charge repeated 40 times a second is equivalent to a steady current of 40 micro-amperes. Where m is the capacity in microfarads ($k = 10^{-15} \cdot m$), and to determine m we have the equation, $20\,m\left(1-e^{-\frac{1}{24\,m}}\right)=1$. From this m is a little greater than ·05. This capacity, ·05 microfarad, for an area ·8 sq. cm. (that of the crater) is so much less than that of any known liquid electrolyte, being itself the extreme maximum value indicated by the experiments, that M. Blondel infers than no similarity between the two can be probable. The observations, however, give little ground either for the calculation or the reasoning based on it.

He concludes as follows:—"It seems to me definitely established by these measurements that the electric arc does not behave in an appreciably different manner from a resistance, and presents no back electromotive force, in the ordinary sense of the word, comparable to the difference of potential observed; it is not due, then, to a phenomenon of electrolysis. We may be certain, within the degree of accuracy obtained, that if a residual electromotive force exists due to thermo-electric effects, this does not exceed a fraction of a volt."

As to these conclusions:—The experiments appear to indicate 2·4 volts as the major limit of the last quantity, while they prove nothing as to the similarity of conduction through an arc, and through a metallic conductor, except that in both cases all action ceases with the interruption of the current. This has been shown before, though not so far as we know so distinctly, and it is clearly an important observation.

Of the other two papers, one contains a number of interesting diagrams of the periodic curves of current and electromotive force taken from alternating arc lamps. The subject they open is too large to be dealt with in a short notice, but we may refer our readers to the *Comptes Rendus* for them. The last paper, also from the *Comptes Rendus*, is an account of an examination of the intensity of the reflection from a large search light.

A TRUE STORY.

By W. PERREN MAYCOCK, M.I.E.E.

There was once a very eminent Professor, great on matters mechanical and mathematical, and to some extent electrical; but there were things in practical work that this Professor did not know.

And it came to pass that the question cropped up of electrically lighting the imposing building in which the professorial lectures were delivered; and the Professor was greatly exercised in his mind as to the wiring thereof. "Ah!" thought he at last, "I will write to the young consulting engineer who has devoted much time to these matters, and get his opinion and advice thereon."

Thus it was that the young engineer received a letter of inquiries from the great Professor; the two, be it noted, not being personally acquainted. And the engineer duly answered those inquiries in a manner which was acknowledged satisfactory by the Professor; and in due course a reasonable charge was made for the same.

Then did the mighty Professor arise in his wrath, and state his belief that he was at liberty to suck the brains of others in the same profession without making return therefor. At this the engineer became wrathful also to think that one so high and mighty should possess so mean a soul; and he determined to fight the matter out to the bitter end.

And the lawyers were consulted, and after much interchange of letters it was decided to refer the matter to arbitration by two engineers of renown. After many days their decision was made known, and lo! and behold, it was against the poor consulting engineer, whose belief in the existence of a spirit of fairness and common sense amongst his fellows has consequently received a rude shock.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

1,487. "Improvements in electric light wire casing." A. Davidson. Dated January 23rd.

1,493. "Apparatus for heating by electricity." P. John. Dated January 23rd.

1,502. "Improvements in electric igniters and vaporisers for internal combustion engines." W. H. Debriman and W. E. Philbrow. Dated January 23rd.

1,513. "Improvements in electrical insulating cement." F. Player and P. Holmes. Dated January 23rd.

1,522. "Improvements in dynamos and electric motors." F. O'Connor. Dated January 23rd.

1,526. "Improvements in or relating to electric meters." G. W. Walker Dated January 23rd.

1,529. "Improvements in electric measuring instruments." F. H. Naldeb, E. Thompson, and R. F. Curtis. Dated January 23rd.

1,553. "Improvements in secondary or storage batteries." W. M. McDougall. Dated January 23rd.

1,554. "Improvements in the manufacture of secondary battery plates." W. M. McDougall. Dated January 23rd.

1,598. "Improvements in adjustable flexible metallic supports or arms for electric lights." G. Howson and W. Barnes. Dated January 24th.

1,620. "Improvements in trolley connections for transmitting electric power from overhead wires to tramcars and the like." R. Baird. Dated January 24th.

1,627. "Improvements in insulators for fastening electric wires." J. Trelevan. Dated January 24th. (*Complete.*)

1,643. "Improvements in speed indicators for electric tramcars." H. F. Parshall. Dated January 24th.

1,673. "Improvements in portable telephones, applicable also for testing purposes." H. F. Blackwell, jun., and M. A. Blackwell. Dated January 24th.

1,683. "Combined electric arc lamps and fans." J. Melzeb, F. Haffneb, and M. Koch. Dated January 24th. (*Complete.*)

1,740. "Improvements in and relating to motor starting switches and other like apparatus." T. E. Ritchie. Dated January 25th.

1,758. "Improvements in portable hand dynamos, parts of which improvements are applicable to small power dynamos and motors for other purposes." Eversheb & Vignoles, Ltd., and S. Eversheb. Dated January 25th.

1,765. "A surface contact electric traction system." S. P. Thompson and M. Walker. Dated January 25th.

1,774. "Electric boot or shoe." B. Kellermann and B. Kellermann. Dated January 25th.

1,810. "Improvements in electrical weaving frames or looms." H. Boulange and E. Fregnac. Dated January 26th. (*Complete.*)

1,819. "A means of recording messages as they are received through a telephone or an easy method of taking a record of messages as they are received through the telephone." T. Williams and T. L. Heathfield. Dated January 26th.

1,834. "Improvements in rail bonds for electric traction systems." H. Hirst and I. V. Zealander. Dated January 26th.

1,835. "Improvements in switches for starting and controlling electric motors." H. Hirst and W. Mead. Dated January 26th.

1,839. "Improved method of solidifying the contents of electric accumulators by chemical means." L. Fiedler and E. Jackel. Dated January 26th.

1,841. "Improvements in and relating to collectors for trolleys for electric tramways and the like." R. N. Tweedy. Dated January 26th.

1,844. "Improvements in the manufacture of plates for secondary batteries." L. Champagne. Dated January 26th.

1,862. "Electric telegraphy by means of condensers and induction coils." F. Braun. Dated January 26th.

1,863. "Wireless electric transmission of signals over surfaces." F. Braun. Dated January 26th.

1,865. "Method of and apparatus for controlling the operating gears of rudders, signals, and the like by means of heat, light, or electrical waves." A. Orling and C. G. G. Braunerhjelm. Dated January 26th. (Date applied for under Patents, &c., Act, 1883, Section 103, October 26th, 1898, being date of application in Sweden.)

1,866. "An improved receiver for waves of light, heat, or electricity." A. Orling and C. G. G. Braunerhjelm. Dated January 26th. (Date applied for under Patents, &c., Act, 1883, Section 103, October 27th, 1898, being date of application in Sweden.)

1,867. "Improvements in apparatus for regulating the sensitivity of receivers for waves of light, heat, or electricity." A. Orling and C. G. G. Braunerhjelm. Dated January 26th. (Date applied for under Patents, &c., Act, 1883, Section 103, October 27th, 1898, being date of application in Sweden.)

1,869. "Improved electrical condenser and apparatus for producing powerful electric waves." A. Orling and C. G. G. Braunerhjelm. Dated January 26th. (Date applied for under Patents, &c., Act, 1883, Section 103, October 27th, 1898, being date of application in Sweden.)

1,895. "Improved electric switch." R. M. Murray. Dated January 27th.

1,902. "Improvements in the manufacture of secondary battery plates." V. G. Liboni. Dated January 27th.

1,921. "Improvements in electric arc lamps for stage and the like purposes." J. Webster. Dated January 27th.

1,927. "A new or improved magnetic clutch." C. W. Higgs. Dated January 27th.

1,941. "Improvements in incandescence electric lamp pendants or brackets." H. Hirst and J. Murphy. Dated January 27th.

1,960. "Improvements in electric railways of the sectional conductor type." J. G. Lorrain. (F. C. Esmond, United States.) Dated January 27th.

1,978. "Improvements in electric glow lamp sockets or holders." V. G. Liboni and O. Moon. Dated January 28th.

2,017. "An improvement in electric igniters for gas or oil motors." P. A. Decam. Dated January 28th.

2,028. "An improved manufacture of carbons for electric arc lamps." E. Frischaner and A. O. Simonnier. Dated January 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free*, 9d. *(in stamps)*.

1898.

12,893. "Improvements in safety devices for electrical circuits." L. J. Steele. Dated August 17th, 1898. Refers to the reduction of high tension currents to low tension circuits, and the danger of the high tension current passing to the low tension circuit if any fault exists in the system. To supply a means for the high tension current to pass directly to earth if this occurs is the object of the present invention. One pole of the low tension system is electrically connected to a piece of carbon in the shape of a cylinder. The cylinder has a cover of insulating material with an aperture made round a portion of its periphery. To the cover is fixed a thin sheet of mica in which slits are made, allowing portions of the carbon cylinder at the back to be exposed at the place where the aperture exists in the outer tube. This thin insulation acts as a separation between the stretched metallic wire connected to earth and the metallic surface behind it. If the high tension current should pass to the low tension circuit, a spark will be set up between the metallic surface and the stretched wire. The wire will fuse, and the act of doing so will release some contrivance which will make substantial metallic connection between the secondary low tension circuit and earth. 4 claims.

13,273. "Improvements in systems of electrical distribution." The British Thomson-Houston Co, Limited. (C. P. Steinmetz.) Dated June 14th, 1898. Relates to mono-cyclic systems of distribution, and consists in combining therewith a three-wire system, whereby light and power may be supplied from the same generator. A source of single-phase electromotive force is provided, and a three-wire system of the ordinary type is connected to it. To this three-wire system, or to translating devices connected to it, is applied a source of dephased electromotive force. Single-phase translating devices are also connected to the three-wire system in the ordinary way, and multiphase translating devices are connected between any two wires of the three-wire system (but preferably the two outside wires) and the supplementary wire. 8 claims.

13,274. "Improvements in generators for use in systems of electrical distribution." The British Thomson-Houston Co, Ltd. Dated June 14th, 1898. Relates to generators for use in systems of electrical distribution, whereby light and power may be supplied from the same generator. Consists of a dynamo-electric machine, having out-of phase coils connected to three collector rings, and the remaining terminal of one coil connected to an intermediate point in the second coil, and a fourth collector ring likewise connected to the intermediate point in the last named coil. 1 claim.

13,399. "Method of combined application of continuous and alternating currents for exciting magnetic fields and combination apparatus for producing by this method electrical energy and mechanical power." M. Déri. Dated June 15th, 1898. Relates to the combination in a dynamo of two different arrangements for exciting the magnetic field and for the induction, whereby the machine is enabled to be worked as motor by both descriptions of currents, or again to operate as a motor-generator for converting the one kind of current into the other. When operating as generator of continuous current or as continuous current motor, this machine works in the ordinary way with commutator and brushes, when working as alternating current generator or motor it operates with short-circuited armature; the two different actions are produced by an armature and a field magnet, of which the latter is excited simultaneously by continuous and alternating currents. 4 claims.

14,090. "Improvements in means of lowering the load of cranes or hoists driven by electro-motors." T. H. Royce. Dated June 23rd, 1898. Relates to improvements in a means of lowering the load of cranes or hoists driven by electro-motors. It depends on the action of a solenoid which by drawing a core into itself applies a brake. To quicken the descent resistances are put into the circuit. The weight of the load works the motor as a dynamo. 2 claims.

14,732. "Method for obtaining combined alternating and continuous currents for distributing the same for the electrical transmission of power, particularly for electrical traction." M. Déri. Dated July 24th, 1898. An alternating current is sent out through the primary leads from the central station. The secondary stations comprise alternating current transformers and secondary generators of continuous current, such as accumulators or transformers for converting alternating into continuous current. The secondary generators for alternating currents and for continuous currents are arranged in series or connected together. 3 claims.

14,793. "Improvements in electric insulators." The British Thomson-Houston Co, Ltd. (B. Willard). Dated July 5th, 1898. Relates to insulators which are designed to support a conductor rail. The insulator is provided with a rectangular metal cap having downwardly projecting sides which are flared at their lower ends to form a water shed, so that water will not run down the sides of the insulating block. On top of the cap and formed integral therewith are two lugs adapted to grip the lower flange of the conductor rails. Situated on opposite sides of the block and at an angle to each other are holes arranged to receive the lag screws for securing the insulator to the cross tie. 6 claims.

14,907. "An improved arc lamp with magnetic carbon movement." F. Klostermann. Dated July 6th, 1898. The mechanism of the lamp consists of a thick wire bobbin with a movable armature, an actuating bobbin with the movable armature of same with blades, a spring lever, a governing wheel, a brake, and positive carbon holders. By reason of the current traversing the bobbin, the armature is instantly drawn towards the fixed armature. The armature being attracted, the pulley descends the same distance, and the ribbon which supports the negative carbon-holder also descends. The negative carbon is thus separated from the positive carbon, and the arc light manifests itself. 8 claims.

15,222. "Improvements in electric accumulators." H. H. Lake. (J. Burns.) Dated July 11th, 1898. Relates to an improved accumulator more especially designed for electric traction. The positive electrode is formed of horizontally superposed plate, variable in number. A corrugated plate is placed on a flat plate, and so on until a column of suitable height is formed. Both sets of these plates are cut out with a punch, and have an opening at their centre. These plates have projecting ears, which serve to solder the blades by means of a bar of lead, which serves as an electrode. The negative electrode is constructed with a thin sheet or plate of lead folded down upon itself, so as to form a prism, the interior of which is hollow, forming a lead pocket. The hollow inner space is subsequently filled with salts of lead, which are then reduced to spongy lead. The lead cover has been previously pierced with a large number of small holes, very closely approaching one another. The object of these holes is to enable the acidulated liquid to easily enter the body itself of the electrode and of the active material. 4 claims.

15,303. "An improved method of, and apparatus for, generating and utilising electricity." H. H. Lake. (J. J. Teely.) Dated July 12th, 1898. Relates to a method and apparatus for generating electricity. The apparatus consists of a dynamo, of which the pole-pieces of the field magnets are connected by an iron core, forming a magnetic shunt round the armature; field coils are connected in shunt with the armature, and a coil is put in series with the field coils and wound on the iron core. All the coils are of a high resistance, and consist of a large number of turns. 8 claims.

20,279. "Improvements in apparatus for registering the number or duration of telephonic conversations." R. Haddon. Dated September 24th, 1898. Relates to a device for registering the length of time a telephone subscriber uses his instrument in actual conversation with other subscribers. By means of a contact device operated from the place called up when the receiver is taken off its hook both stations are connected in such a manner for a short time, that the current then passing is strong enough to operate at the call end a clock and registering apparatus. Such a current may be produced in different ways; for instance, the said circuit closing or contact device connects in series at the given the element groups at both stations put generally into circuit against one another, or one of these element groups is put out of circuit and only the current of the group remaining is used for operating the clock and registering work, or a branch wire passing from the speaking wire to the ground is inserted by a time contact, and the current of the elements in this wire is used for operating the clock and registering work. 10 claims.